



STANFORD RSL TECH REPORT #67-3

"STATISTICAL ANALYSIS OF IR SPECTRA -
STANFORD PROGRAMS APPLIED TO USGS
SPECTRA IN TECH LETTER #13"

GPO PRICE \$ _____

\$ 8.75

CFSTI PRICE(S) \$ _____

Hard copy (HC) _____

Microfiche (MF) _____

ff 653 July 65

N88-157

FACILITY FORM 602

ACCESSION NUMBER
108

PAGES
135-94

(NASA CR OR TMX OR AD NUMBER)

(THRU)

(CODE)
13

(CATEGORY)

NOV. 10, 1967

NR-09-DL-998-0070

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Already Issued

67-2 - "Field Infrared Analysis of Terrain - Spectral Correlation
Program".

Part II (67-1)

Part II (67-2)

Part III (67-2)

This research was performed under NASA grant NGR-05-020-115 in the
Stanford University Remote Sensing Laboratory.

November 10, 1967

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I. INTRODUCTION

6. Analysis of USGS IR Spectra - Tech Letter #13

Daniels (1966)* has published infrared emittance spectra (8 - 14 microns) of 13 rock samples from the Pisgah Crater and Mono Craters test sites. The samples include felsic plutonic and volcanic rocks from Mono Craters and mafic volcanic rocks from Pisgah Crater. Specifically, spectra were taken of the following samples:

Mono Craters

- (2) obsidian
- (2) rhyolite pumice
- (2) Bishop tuff
- (1) quartz monzonite

Pisgah Crater

- (2) pahoehoe olivine basalts
- (4) aa olivine basalts

The 13 spectra were taken of heated samples with a Block Engineering Model I-4T interferometer spectrometer equipped with an ambient temperature thermistor bolometer detector.

We have digitized the 13 spectra by hand at a 0.1 micron interval from 7.8 to 13 microns and statistically analyzed the data according to our now, fairly routine algorithms..

a. Correlation Coefficient Ranking (CORRCO) Program

We have prepared secondary entry points in the LMSC CORRCO program (See SRSL Tech Report 67-2, p. 41) so that spectral emittance ratios taken from other sources, as from Daniels for example, can be used and compared against our library of 19** rocks in the memory of the computer.

In order to conserve space we have only presented the five rocks which best fit (i.e. top five rankings) and the two which are the worst

* Daniels, D.L., 1966 "Infrared Spectral Emittance of Rocks from Pisgah Crater and Mono Craters area, California", USGS Technical Letter NASA-13, pp 1-20.

** Changed from 50 to 19 because of redundancy in the rock types.

fit (i.e. lowest two rankings) for each of the 13 input spectra. The data are summarized in Table XI which shows that the correct rock type was chosen first only 4 times.

TABLE XI
SPECTRAL MATCHING SUMMARY

<u>USGS #</u>	<u>ROCK TYPE</u>	<u>CORRCO RANKING OUT OF 19 CHOICES</u>
<u>Mono Lake, California</u>		
73	Obsidian, grey	2nd
74	Obsidian, black	2nd
85	Rhyolite pumice, weathered	1st
75	Rhyolite pumice, weathered	1st
79	Bishop Tuff (upper)	1st
80	Bishop Tuff (lower)	3rd
78	Quartz Monzonite, weathered	3-4th
<u>Pisgah Crater, California</u>		
71	Basalt, pahoehoe, weathered	10th
72	Basalt, pahoehoe, sawed	2nd
89	Basalt, aa, weathered	13th
86	Basalt, aa, weathered	5th
91	Basalt, aa, weathered	9th
90	Basalt, aa, rough	1st

The detailed listing in Table XII however shows that a "reasonable fit" (i.e. obsidian for rhyolite pumice) was made in 10 out of the 13 cases. The other 3 chose a single mineral (K-feldspar) rather than the rock.

The discrimination is good, but not excellent. There is some doubt about the basalt spectra, and when one redigitizes spectra, which are already drafted, there is a problem of obscuring information which may have been present in the original spectra.

TABLE XII
DETAILED SPECTRAL MATCHING - USGS SAMPLES

USGS 73 Obsidian, gray smooth, Mono Craters (Obsidian ranked 2nd in 19)

Rhyolite pumice	97%
Obsidian	97
Pyrox aplite	92
Welded tuff	91
<u>Granite, rough</u>	88
Meteorite	- 14
Dunite Rough	- 23

USGS 74 Obsidian, black smooth, Mono Crater (Obsidian, ranked 2nd in 19)

Rhyolite pumice	98%
Obsidian	97
Pyrox. aplite	93
Welded tuff	91
<u>Granite, rough</u>	88
Meteorite	- 9
Dunite	- 17

USGS 85 Rhyolite pumice, weathered rough, Mono Crater (Rhy. pumice ranked 1st in 19)

Rhyolite pumice	90%
Obsidian	83
Hyp. andesite	80
Welded tuff	79
<u>Aug. diorite rough</u>	79
<u>Polystyrene</u>	7
Dunite rough	7

USGS 75 Rhyolite pumice, weathered rough, Mono Crater (Rhyolite pumice ranked 1st of 19)

Rhyolite pumice	95%
Obsidian	91
Welded tuff	91
Pyrox. aplite	89
<u>Granite rough</u>	86
Farmington meteorite	- 16
Dunite rough	- 26

USGS 79 Bishop tuff, upper unit rough, Mono Crater (welded tuff ranked 1st in 19)

Welded tuff	96%
Rhyolite pumice	95
Pyrox aplite	94
Granite rough	93
<u>Obsidian</u>	92
Farm. Meteorite	- 15
Dunite rough	- 24

USGS 80 Bishop tuff, lower unit rough, Mono Crater (welded tuff ranked 3rd in 19)

Rhyolite	96%
Obsidian	92
Welded tuff	89
Pyrox aplite	88
<u>Granite rough</u>	85
Farm. meteorite	- 14
Dunite rough	- 23

USGS 78 Quartz monzonite, weathered Mono Crater (QMP rough ranked between 3 & 4 in 19)

Pyrox. aplite	98%
Welded tuff	96
Granite rough	96
<u>Obsidian</u>	94
<u>Rhyolite pumice</u>	93
Farm. meteorite	- 17
Dunite rough	- 23

USGS 71 Basalt, pahoehoe, weathered rough, Pisgah Crater (ranked 10th in 19)

K-feldspar, rough	94%
Augite diorite, rough	90
Quartz diorite	87
Andesite	85
<u>Neph. syenite</u>	84
Calcite	15
Dunite, rough	12

Table XII (continued)

USGS 72 Basalt, pahoehoe, sawed,
Pisgah Crater (ranked 2nd in 19)

Q. diorite	88%
Basalt	87
Serpentine	86
Hyp. andesite	86
K-feldspar, rough	85
Calcite	22
Qtz. beach sand	- 4

USGS 89 Basalt, AA weathered, v.
rough Pisgah Crater (ranked 13th
in 19)

Andesite	90%
Neph. syenite	88
Aug. diorite, rough	86
K-feldspar, rough	84
Obsidian	83
Meteorite	8
Dunite, rough	- 8

USGS 86 Basalt, AA, weathered v.
rough, Pisgah Crater (basalt ranked
9th in 19)

K-feldspar rough	87%
Aug. diorite rough	80
Hyp. andesite	75
Quartz diorite	71
Basalt	71
Polystyrene std.	12
Calcite	10

USGS 91 Basalt, AA, weathered v.
rough, Pisgah Crater (basalt ranked
9th in 19)

K-feldspar rough	97%
Aug. diorite rough	91%
Quartz diorite	84
Hyp. andesite	83
Serpentine	83
Polystyrene std.	21
Calcite	7

USGS 90 Basalt, AA, rough broken,
Pisgah Crater (basalt ranked
1st in 19)

Basalt	91%
Hyp. andesite	87
Serpentine	83
K-feldspar rough	81
Quartz diorite	80
Polystyrene standard	- 1
Quartz beach sand	- 13

b. Step-wise Discriminant Program

A second method of analysis concerns the discrimination of the various rock types represented by the spectra. This analysis is more satisfactory than computed modes because within-sample (rock type) spectral variation, while large per se, is less than between-sample spectral variation and the discrimination analysis is able to discriminate between rock types rather well in certain respects. All felsic volcanic rocks from Mono Craters cluster closely, and apart from the cluster of the basalts from Pisgah Crater. (See Fig. 10) The 13 test spectra were classified into one of three groups (granite, basalt, pumice), the 3 groups previously set up with our own spectra. In this respect, the program is less than satisfactory. Most of the felsic volcanic rocks would be classified by most geologists as pumices, yet the program classifies them as granites. It should be noted however that the felsic rocks correspond quite closely to granite in composition, but differ markedly in texture. The program classified 4 out the 6 basalt spectra correctly as basalt, the two incorrect classifications being assigned to the granite class.

c. Mineral Ratios Program

The third method of statistical analysis consisted of an attempt to compute modal analyses for the 13 rocks from the library mineral spectra compiled from our 22 library samples. This analysis has proved to be less than satisfactory. We have found that the standard error of each of the computed component minerals is incredibly large, and then the computed modal analyses are essentially meaningless. We attribute this factor to the high "noise level" of the 13 spectra and the general lack of similar shape in spectra from compositionally and texturally similar rocks.

In summary, it is encouraging to note that the step-wise discrimination program (b) is able to sort out and cluster spectra of similar rock types (Fig. 10) but the classification performed by the program (c) in this case is not adequate. We attribute this factor to the generally poor quality of the 13 spectra. We must also note however that the "training" spectral groups used in this program were produced from our own field spectra, taken under very different conditions and with different equipment than the U.S.G.S. spectra.

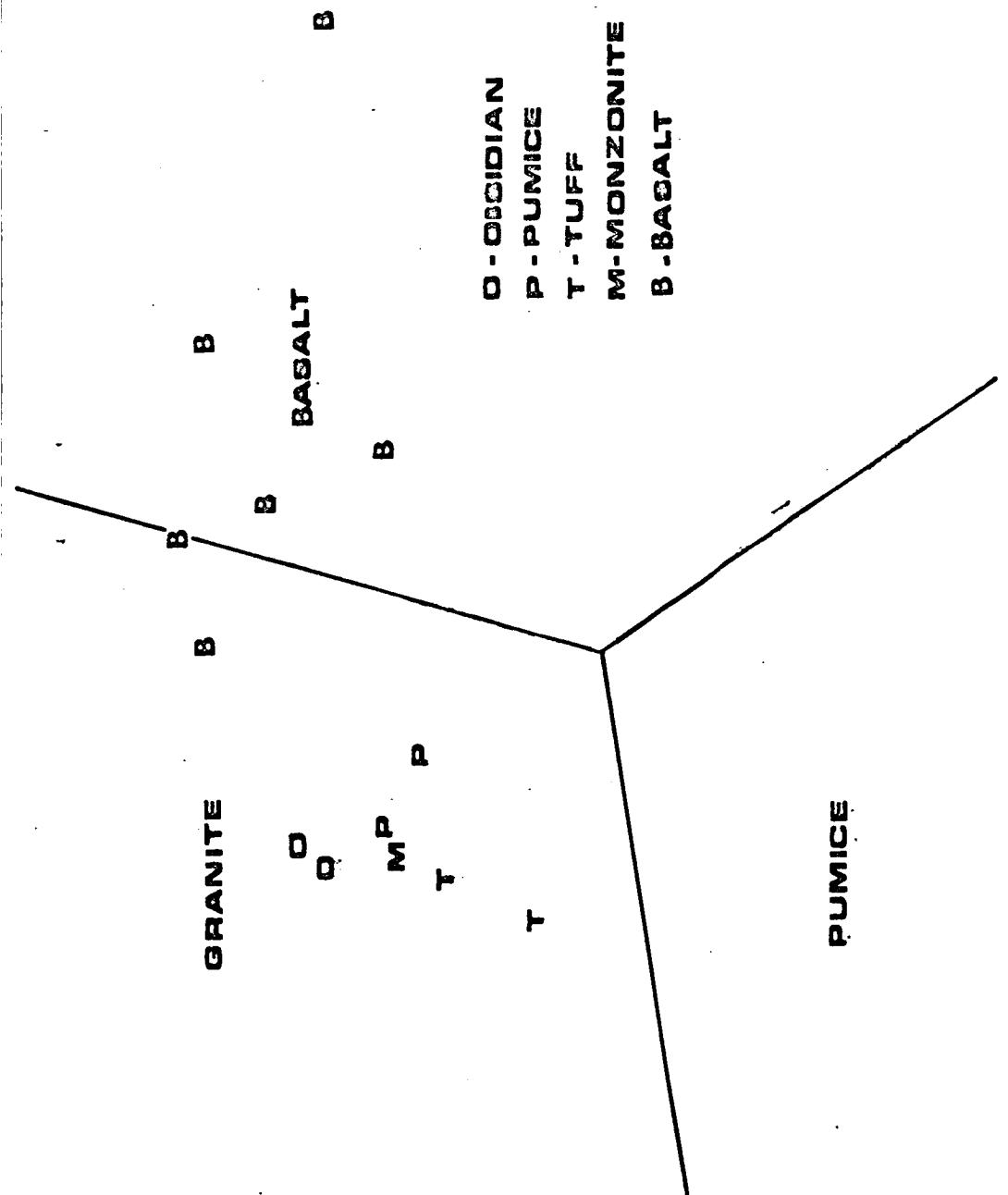


FIGURE 10 - Classification of U.S.G.S. spectra into 3 rock Groups with Use of Discriminant Analysis.

APPENDIX A *

STATISTICAL ANALYSIS OF SPECTRAL MATCHING

Suppose we wish to assign an object to one of several well-defined classes, e.g., we wish to say whether a particular rock is granite, basalt, or pumice. This is no problem if the known characteristics of the rock include those which are used to define the classes. However, if the known characteristics are not the defining ones then it may not be possible to make an assignment with certainty, for example, this would be the case if all we knew about the rock was its color index, or perhaps its emission spectrum over some wavelength band.

Let us look further at the case where our knowledge consists of an emission spectrum, (call it s), which is of particular interest here. Since the emission spectra are not what is used to define the three rock classes, our s may correspond to any kind of rock. However, if the emission spectrum is to have any value in making assignments, it will be more probable that our s corresponds to a granitic rock say than to either of the other two classes, and we therefore will make the assignment granite.

An interpretation of the word "probable" is in order. Loosely speaking, suppose we had taken spectra of every bit of rock in the region of interest. Some of these spectra (say 1000 of them) will be very nearly like the spectrum s . Of these 1000 s -spectra suppose 750 correspond to rocks in the granite class, 200 in the pumice class, and 50 in the basalt class. Hence, if we looked at a spectrum s and called it granite we would have a 75% chance of being right.

Now we introduce some convenient notation. Let $p_G(s)$ denote the probability that a given spectrum s corresponds to a rock in the granite class. Similarly, let $p_B(s)$ and $p_P(s)$ denote the probabilities that this s corresponds to a rock in the basalt and pumice classes, respectively. Then $p_G(s) + p_B(s) + p_P(s) = 1$. Finally, let $P(s)$ denote the probability that s will be correctly classified; then $P(s)$ is the largest of the numbers $p_G(s)$, $p_B(s)$ and $p_P(s)$. In the example of the last paragraph $p_G(s) = 0.75$, $p_B(s) = 0.05$, $p_P(s) = 0.20$ and $P(s) = 0.75$.

-A1-

* Reprinted from Semi-annual report "Field Infrared Analysis of Terrain" under NASA grant NGR-05-020-115, Remote Sensing Laboratory, Stanford University, Stanford, California, May 1967.

Suppose we knew the probabilities $p_G(s)$, $p_B(s)$, and $p_P(s)$ for every possible spectrum s . Then we would know how to make the best possible (most probable) assignments no matter what spectra we encounter, and we would know in each case the probability of a correct assignment. Note, that even in this state of "perfect" knowledge we would still be making assignment errors; however, our error rate would be the minimum possible for the particular wavelength band and the particular rock classes we had chosen. For example if we had n spectra to assign, say s_1, s_2, \dots, s_n , then the expected minimum error rate would be

$$1 - \frac{1}{n} \sum_{i=1}^n p(s_i).$$

In general, our knowledge about the probabilities $p_G(s)$, $p_B(s)$, and $p_P(s)$ will not be precise. Instead, we will have good or not-so-good estimates of these probabilities based on an examination of a number of sample spectra; assignments to a rock class would then be based on the maximum of the estimated probabilities. This results in an assignment error rate higher than the minimum possible rate. For example, by using our estimates we assign the n spectra s_1, s_2, \dots, s_n to the rock classes c_1, c_2, \dots, c_n respectively (where each c_i is either G, B, or P), then the expected error rate is $1 - \frac{1}{n} \sum_{i=1}^n p_{c_i}(s_i)$; this exceeds the minimum possible rate by the amount $\frac{1}{n} \sum_{i=1}^n p(s_i) - p_{c_i}(s_i)$. Let $\hat{p}_G(s)$, $\hat{p}_B(s)$, and $\hat{p}_P(s)$ be our estimated probabilities, and let $\hat{P}(s)$ be the largest of these; then an estimate of the expected error rate for the n spectra is given by $1 - \frac{1}{n} \sum_{i=1}^n p(s_i)$.

We now examine a method for obtaining the probability estimates $\hat{p}_G(s)$, $\hat{p}_B(s)$, $\hat{p}_P(s)$ for every possible spectrum. The first step is to cut the problem down to size in several ways by making assorted assumptions about the "true" probabilities. By doing so it will be possible to obtain relatively simple estimation methods which are reasonable for the restricted problem and which do not appear unreasonable if our assorted assumptions are not strictly valid.

The first assumption we make is that all the information in a spectrum is contained in a specified finite number of wavelengths, e.g. the wavelengths 7.8 microns to 13.0 microns at intervals of 0.1 microns. This says that if two spectra coincide exactly at those 53 wavelengths then the three class probabilities associated with the first spectrum are always the same as those for the second spectrum. This assumption makes our problem finite-dimensional and permits the use of ordinary multivariate statistical methods. The heights of a spectrum at the specified 53 wavelengths will be denoted by h_1, h_2, \dots, h_{53} respectively.

Again, suppose we had spectra of every bit of rock in the region of interest, and let us confine attention to all those corresponding to granite, say. In general the values of h_i (fixing i) will be different for different spectra even though they are all granite. In this way a joint frequency distribution of h_i values is created for the given rock class granite. Let $f_G(h_1, h_2, \dots, h_{53})$ denote this joint frequency distribution. Similarly, we can create the frequency distributions $f_B(h_1, h_2, \dots, h_{53})$ and $f_P(h_1, h_2, \dots, h_{53})$ for the other rock classes - basalt and pumice.

Of course we will never be able to know f_G , f_B , and f_P exactly, but if we did, then we could assign an arbitrary spectrum s^o to a rock class in an optimum way and know its misassignment probability.

Suppose the spectrum s^o in question had heights $h_1^o, h_2^o, \dots, h_{53}^o$; the frequency function having the largest value at this configuration of heights is the one corresponding to the rock class to which the spectrum in question should be assigned - provided no particular class is favoured a priori. This follows because it can be shown that the probabilities $p_G(s^o)$, $p_B(s^o)$, and $p_P(s^o)$, as defined earlier are proportional to the values of $f_G(h_1^o, h_2^o, \dots, h_{53}^o)$, $f_B(h_1^o, h_2^o, \dots, h_{53}^o)$, and $f_P(h_1^o, h_2^o, \dots, h_{53}^o)$.

The proportionality constant is the reciprocal of $f_G + f_B + f_P$ evaluated at $(h_1^o, h_2^o, \dots, h_{53}^o)$.

Therefore, it would be reasonable to try to estimate the joint frequency distributions for the three rock types based on sample spectra taken from the region of interest. In general, this is a hopeless

task unless we make some assumption about the shapes of the three frequency distributions f_G , f_B , f_P . For example, we might assume that f_G , f_B , f_P are each multivariate Gaussian distributions having a common covariance matrix. Roughly speaking this says that the three distributions have identical bell-shapes (in 53 dimensions) and differ only in that they are centered at different points.

The assignment rules derived from this assumption have given an indication of good performance in trial runs, but other assumptions may well lead to rules with better performance. For now we will stick with Gaussian distributions mainly because they afford us mathematical and presentational simplicity. The problem of estimating three multivariate distributions is thus reduced to the estimation of a covariance matrix (call it S) and three center locations or means (call them H^G , H^B , H^P). We will be able to estimate probabilities and make assignments once we have estimates of S , H^G , H^B , and H^P .

Now suppose we have a certain number of sample spectra known to be granites and chosen randomly from the region of interest. Let h_i^G denote the height at wavelength i averaged over all these known granite spectra, then $(h_1^G, h_2^G, \dots, h_{53}^G)$ is a reasonable estimate of H_G . Also let s_{ij}^G denote the covariance between the i -th and j -th wavelengths using the known sample granite spectra. Then the 53×53 matrix of all possible such covariances provides a reasonable estimate of S . Similarly a sample of spectra known to be basalts will provide us with an estimate of H^B and of S , and similarly for pumice. Notice we get three estimates of S , but these estimates should be pooled in the usual way.

Returning now to an unknown spectrum $s^o = (h_1^o, h_2^o, \dots, h_{53}^o)$, we can write down the density f_G of the granite distribution evaluated at this configuration of heights - under the Gaussian assumption and using the estimates of the last paragraph. Similarly we can use our estimates to evaluate the basalt and pumice density functions at this configuration s^o . We will then approximate the optimum assignment by assigning s^o to that rock class having the largest estimated density at s^o .

The logarithms of the three density values are

$$\log f_G(s^o) = -\frac{1}{2} D_G^2(s^o) - \frac{1}{2} \log [\det S] - \frac{53}{2} \log 2\pi$$

$$\log f_B(s^o) = -\frac{1}{2} D_B^2(s^o) - \frac{1}{2} \log [\det S] - \frac{53}{2} \log 2\pi$$

$$\log f_P(s^o) = -\frac{1}{2} D_P^2(s^o) - \frac{1}{2} \log [\det S] - \frac{53}{2} \log 2\pi$$

where $D_G^2(s^o) = \sum_{j=1}^{53} \sum_{i=1}^{53} s^{ij}(h_i^o - h_i^G)(h_j^o - h_j^G)$, s^{ij} is the ij th element of

the inverted covariance matrix S^{-1} , and $D_B^2(s^o)$ and $D_P^2(s^o)$ are the same as $D_G^2(s^o)$ above with the subscript G replaced by B and P respectively.

The quantity $D_G(s^o)$ is sometimes called the Mahalanobis distance (M-distance) between the spectrum s^o and the center H^G of the distribution of granite spectra.

It follows that the rock type whose density value is largest at the configuration s^o is the one whose central value has the smallest M-distance to s^o . In the case that no rock type is favored a priori, the probability that the spectrum s^o is a granite can now be estimated by

$$(1) p_G(s^o) = e^{-1/2 D_G^2(s^o)} / \left[e^{-1/2 D_G^2(s^o)} + e^{-1/2 D_B^2(s^o)} + e^{-1/2 D_P^2(s^o)} \right].$$

Similarly the probabilities $p_B(s^o)$ and $p_P(s^o)$ are estimated by replacing the subscript G in the numerator by B and P respectively.

Until this point the problem of assignment has been viewed as 53-dimensional, inasmuch as a spectrum was represented as a point with 53 co-ordinates (h_1, h_2, \dots, h_{53}) - the heights of the spectrum at each of 53 chosen wavelengths. But regardless of the number of wavelengths chosen, the problem is really only two dimensional in the following sense: there exist pairs of pseudo-variables (let v_1 and v_2 be such a pair) which are linear combinations of h_1, h_2, \dots, h_{53} , say

$$v_1 = \sum_{i=1}^{53} c_i h_i \text{ and } v_2 = \sum_{i=1}^{53} c_i h_i, \text{ with the property that}$$

$$(2) \quad \begin{aligned} (v_1^o - v_1^G)^2 + (v_2^o - v_2^G)^2 &= D_G^2(s^o) \\ (v_1^o - v_1^B)^2 + (v_2^o - v_2^B)^2 &= D_B^2(s^o) \\ (v_1^o - v_1^P)^2 + (v_2^o - v_2^P)^2 &= D_P^2(s^o) \end{aligned}$$

where v_1^G and v_2^G are the average values of v_1 and v_2 taken over all the sample granite spectra, v_1^B , v_2^B , v_1^P , v_2^P , are defined similarly, and v_1^o and v_2^o are the values of v_1 and v_2 computed for the spectrum so to be assigned.

In other words, if v_1 and v_2 are taken as the axes of a two-dimensional plot, then the M-distance from s^o to the center of the granite distribution in 53-space is the same as the ordinary Euclidean distance from (v_1^o, v_2^o) to (v_1^G, v_2^G) in 2-space. This is an especially useful fact for diagrammatic and representational purposes. For example, since probabilities and M-distances are related monotonically as in (1), it follows that the contours of equal probability in (v_1, v_2) -space are concentric circles radiating from each of the three rock-type means (v_1^G, v_2^G) , (v_1^B, v_2^B) and (v_1^P, v_2^P) , furthermore, the locus along which any two rock types are equally probable is the perpendicular bisector of the line joining the corresponding means, and the three such lines will therefore meet in a point at which all three rock types will be equally probable.

The variables v_1 and v_2 are sometimes called canonical variables. The fact that we could reduce the original 53 variables to two canonical variables depended on all our earlier distributional assumptions and the fact that we had three rock types. In general, if there are k rock types, then we can reduce to $k-1$ canonical variables, provided k is not larger than the number of original wavelengths used. Note that, regardless of our distributional assumptions, we can find a v_1 and v_2 such that the equivalence (2) holds, but formula (1) relating probabilities and M-distance holds only under the assumption of Gaussian distributions.

We haven't yet said how to find a pair of canonical variables other than that v_1 and v_2 are two linear combinations of the amplitudes of a spectrum at the 53 specified wavelengths. Sufficient to say here that to find the coefficients of these linear combinations, we need the solution of an eigen-value problem, which can be routinely performed on a computer.

Even though the method of canonical variables allows us to represent the assignment problem and its results in two dimensions, we still need to measure any spectrum on all 53 of its wavelengths in order to compute the values of v_1 and v_2 . The number of "participating" original variables is not reduced by this analysis. If we want to cut down the number of wavelengths used, say to pick the best 10 out of 53, then one would need to do the preceding analysis with all possible sets of 10 wavelengths and see which came out best. This can be quite laborious, even on a computer, but ad hoc approximate methods have been built into some computerized versions of the analysis, which seem to pick a good set of wavelengths (e.g. BMD07M) though not necessarily the best set. In any event, the reduction in the number of wavelengths looked at has nothing to do with the representational reduction afforded by using canonical variables.

Up to this point it has always been assumed that a spectrum s^o to be assigned must necessarily be one of the three rock types for which sample spectra were available. In this framework it is not possible to say that s^o is none of the three named types. This may or may not be disturbing. If the M-distances from s^o to the three rock type means are all quite large there is a temptation not to force an assignment, and this may indeed be sound practice. This may be formalized by saying that all of the three rock types will be rejected if the smallest M-distance to s^o is greater than 4.0, for example. Note, however, that such a decision is outside the conceptual model of our analysis; even if the M-distance to a particular rock type mean is large, the probability for that rock type may still be high if the other M-distances are even larger.

Finally, we look at the case where the three rock types are not equally likely a priori. This would be the case if we had information of the type: the proportion of the region covered by granite is π_G , that covered by basalt is π_B , and that covered by pumice is π_P (where $\pi_G + \pi_B + \pi_P = 1$). Then, the assignment probabilities are no longer given by formula (1). The appropriate modification is

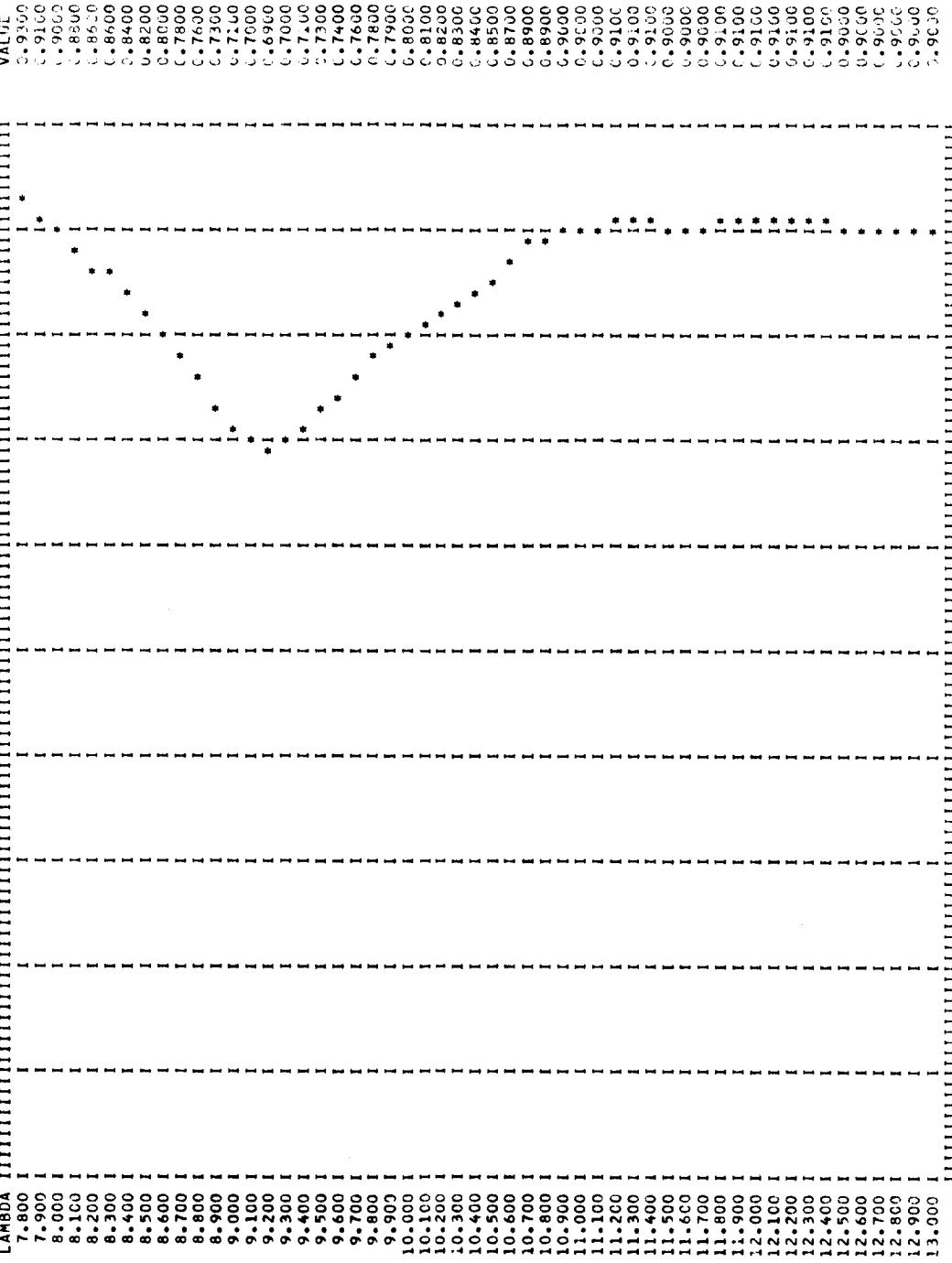
$$P_G(s^o) = \pi_G e^{-1/2 D_G^2(s^o)} / \left[\pi_G e^{-1/2 D_G^2(s^o)} + \pi_B e^{-1/2 D_B^2(s^o)} + \pi_P e^{-1/2 D_P^2(s^o)} \right].$$

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USQS - NASA-13 TECH. LETTER

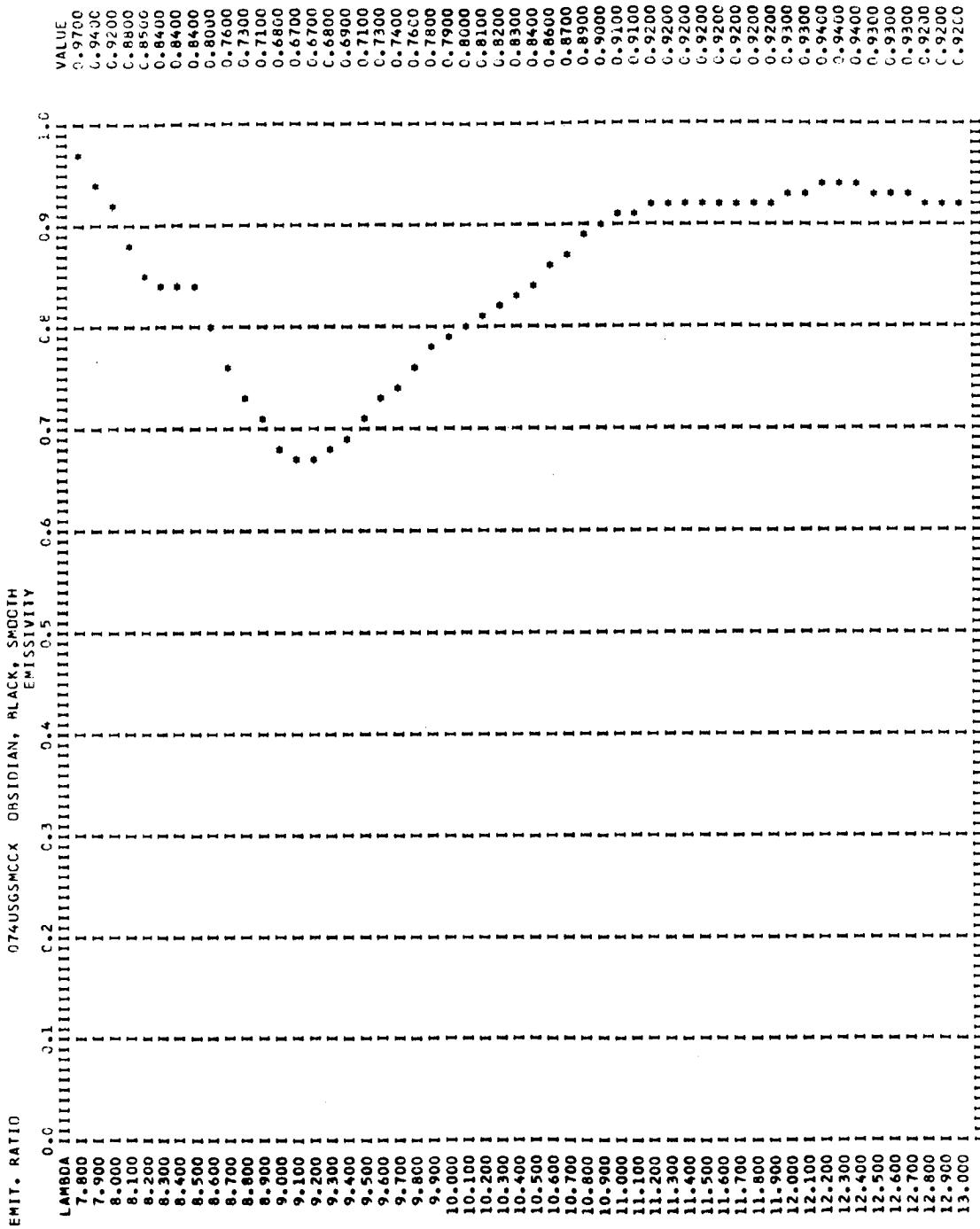
0731:USGSMCCK OBSIDIAN, GRAY, SMOOTH

LAMBDA CMISSIVITY

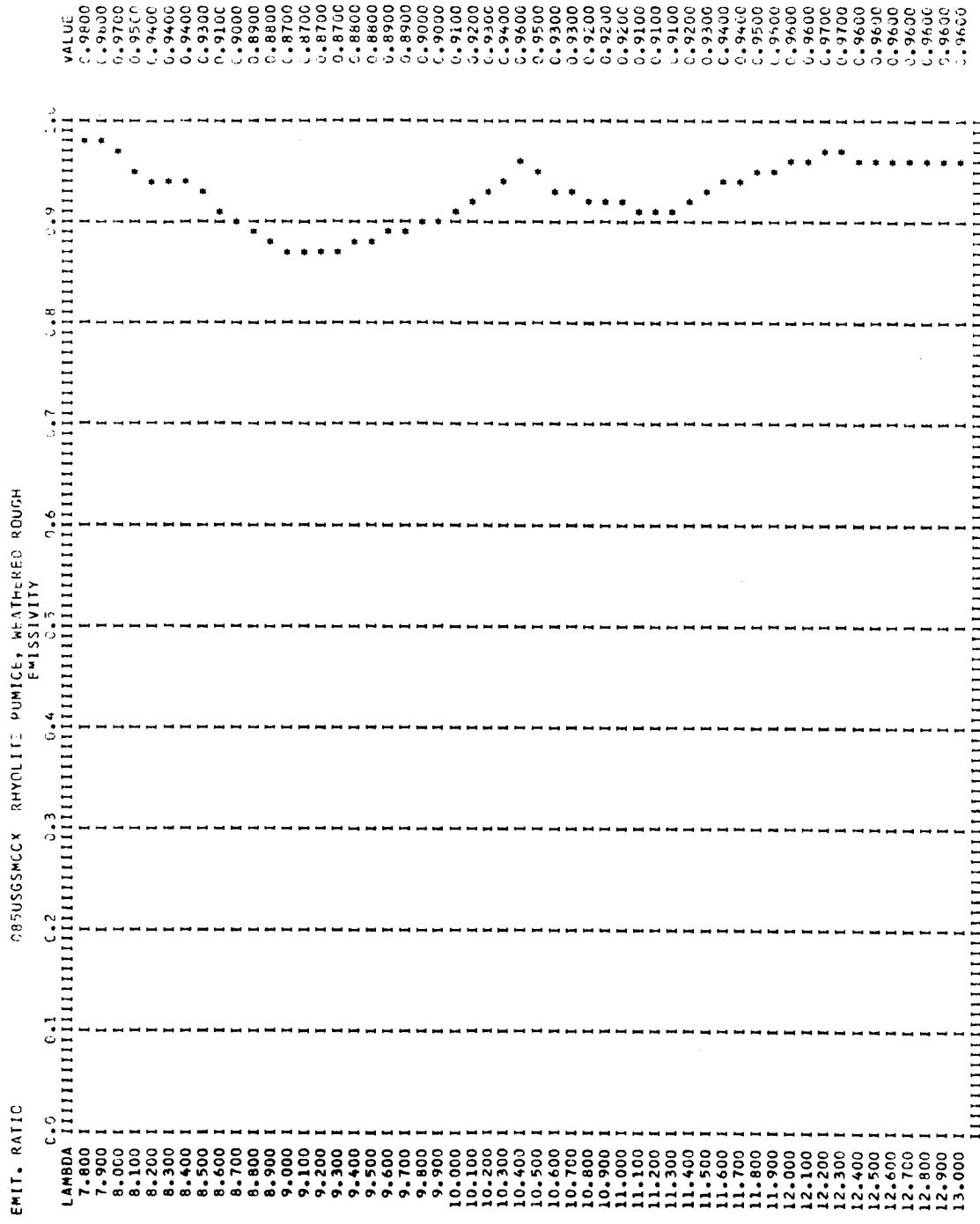


BASIC DATA - REPLOTTED
Daniels, D.A. 1966

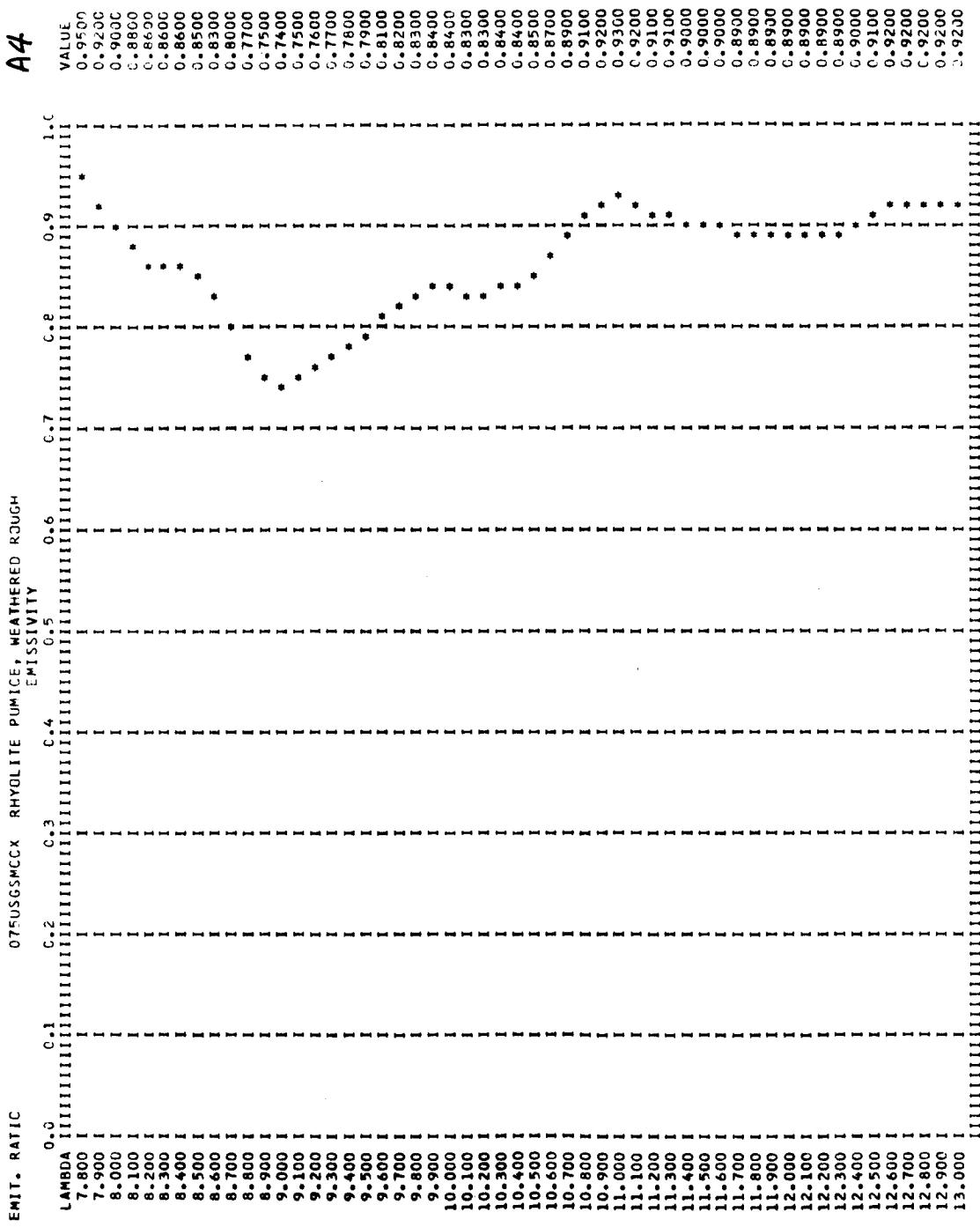
42



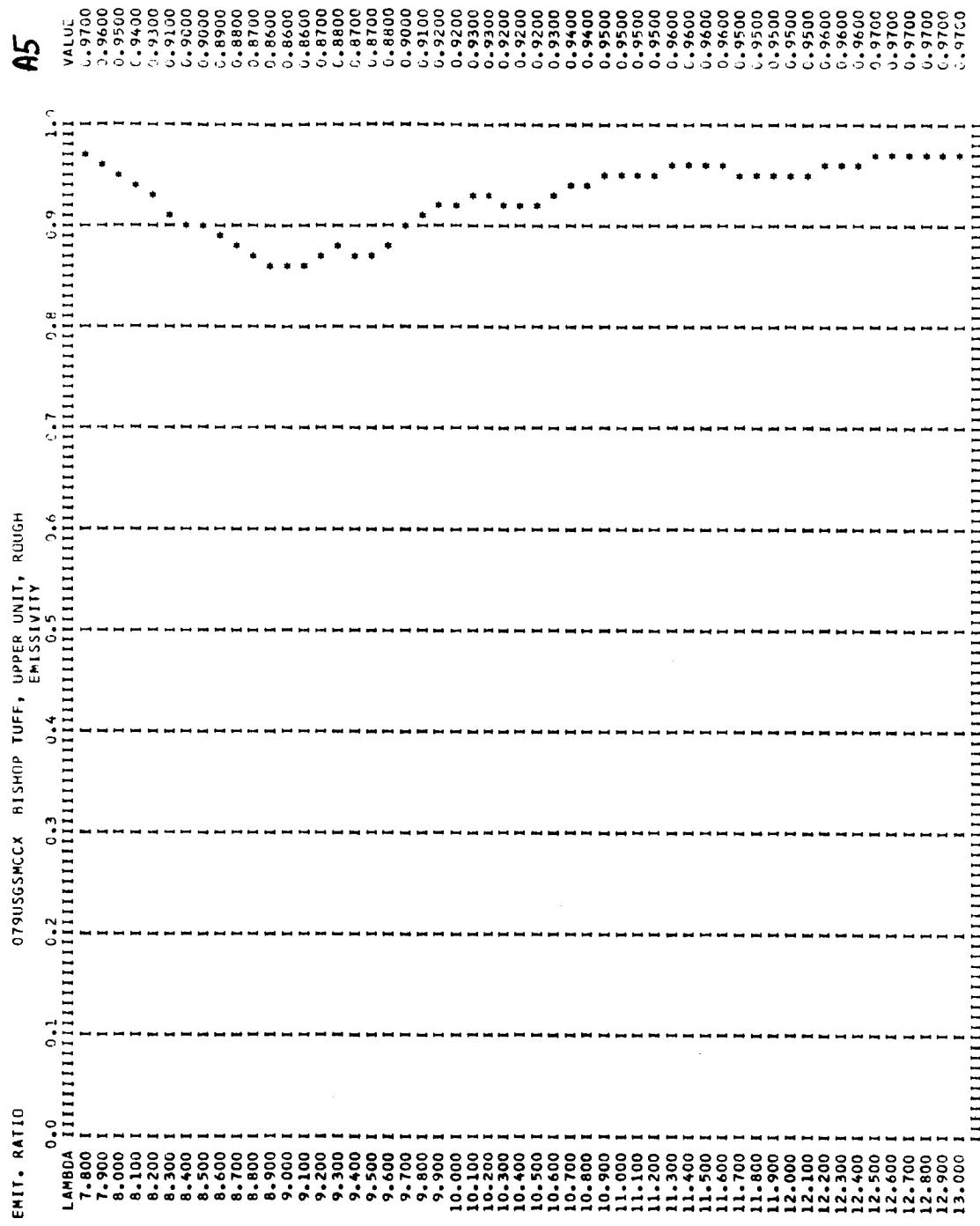
A3



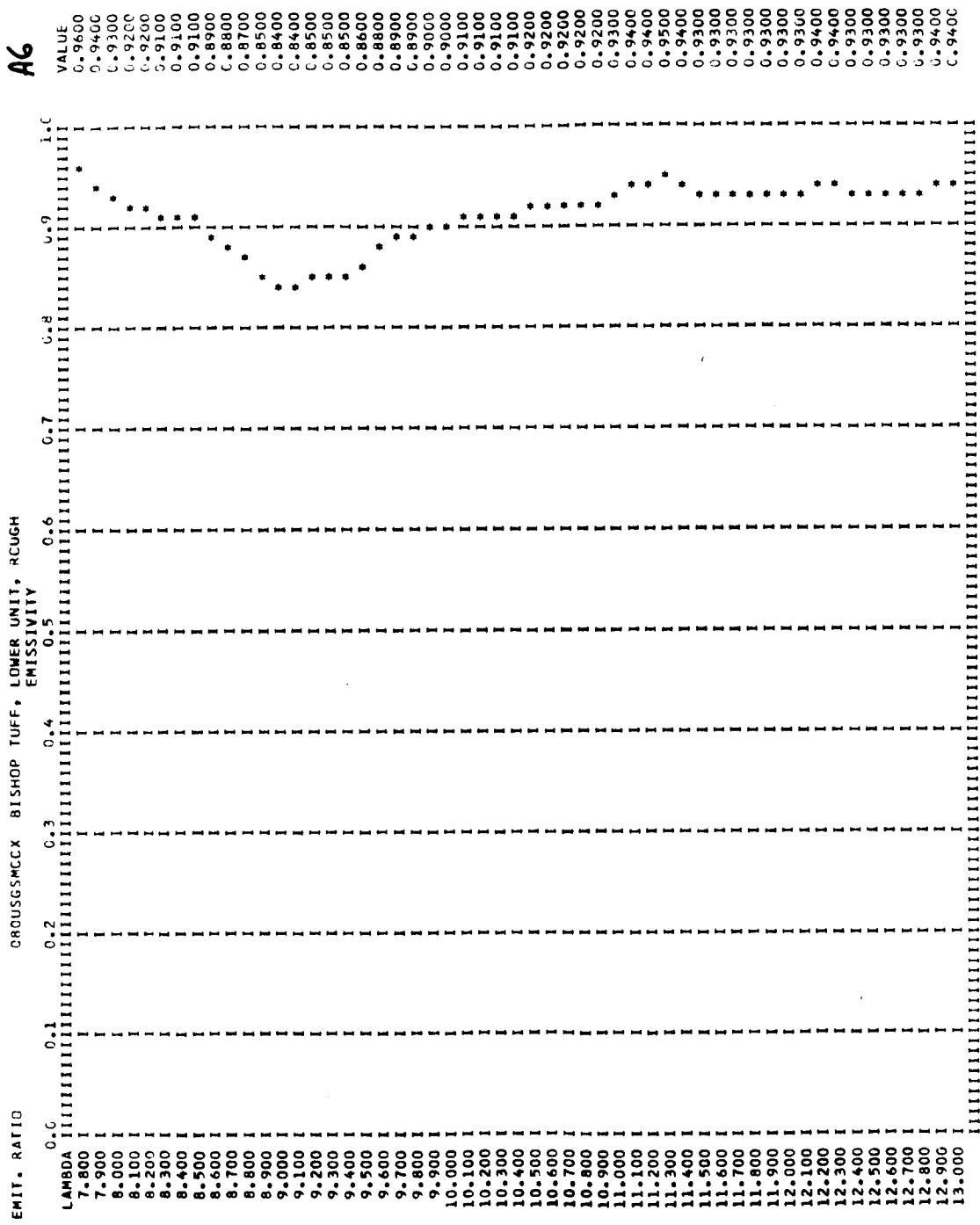
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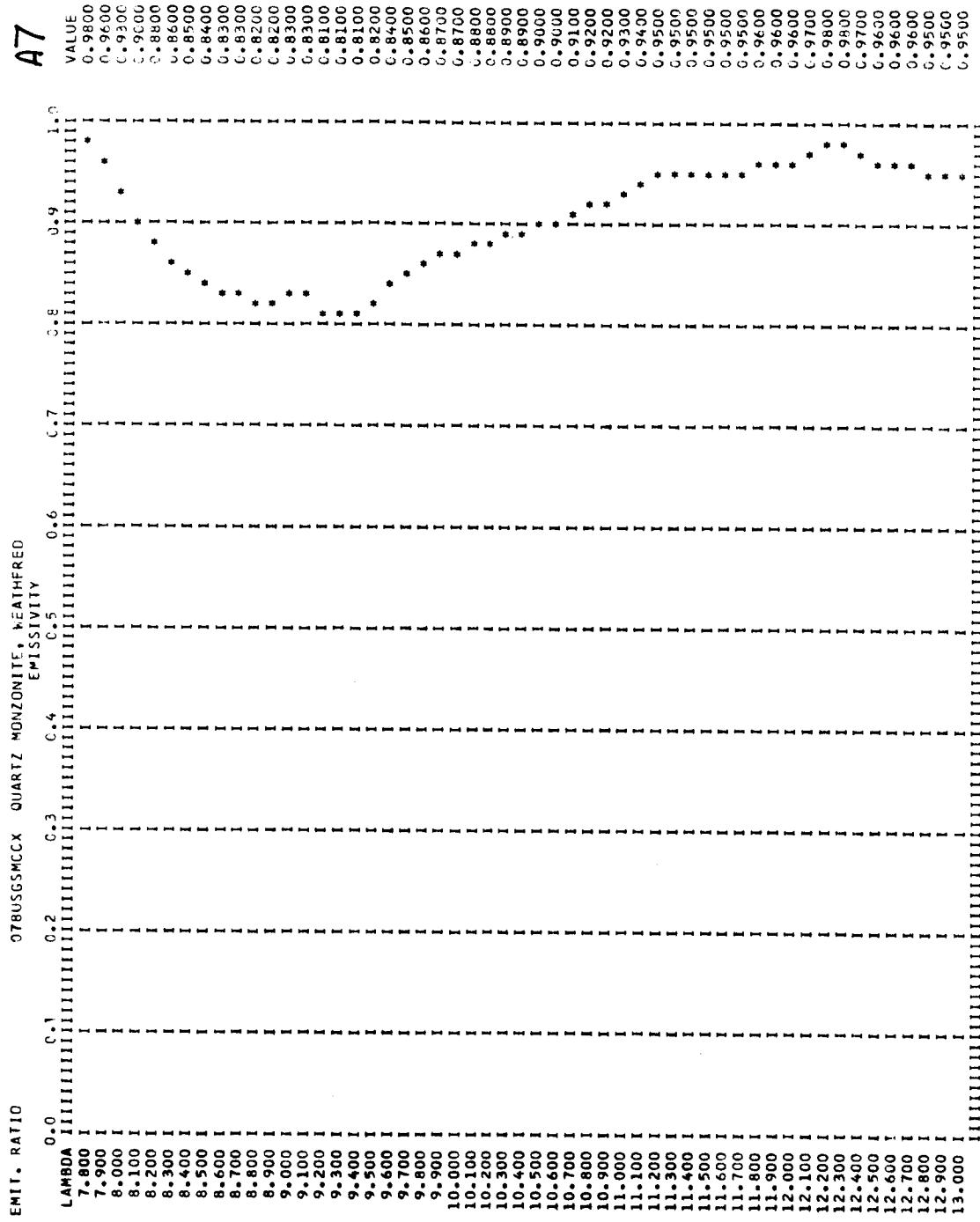
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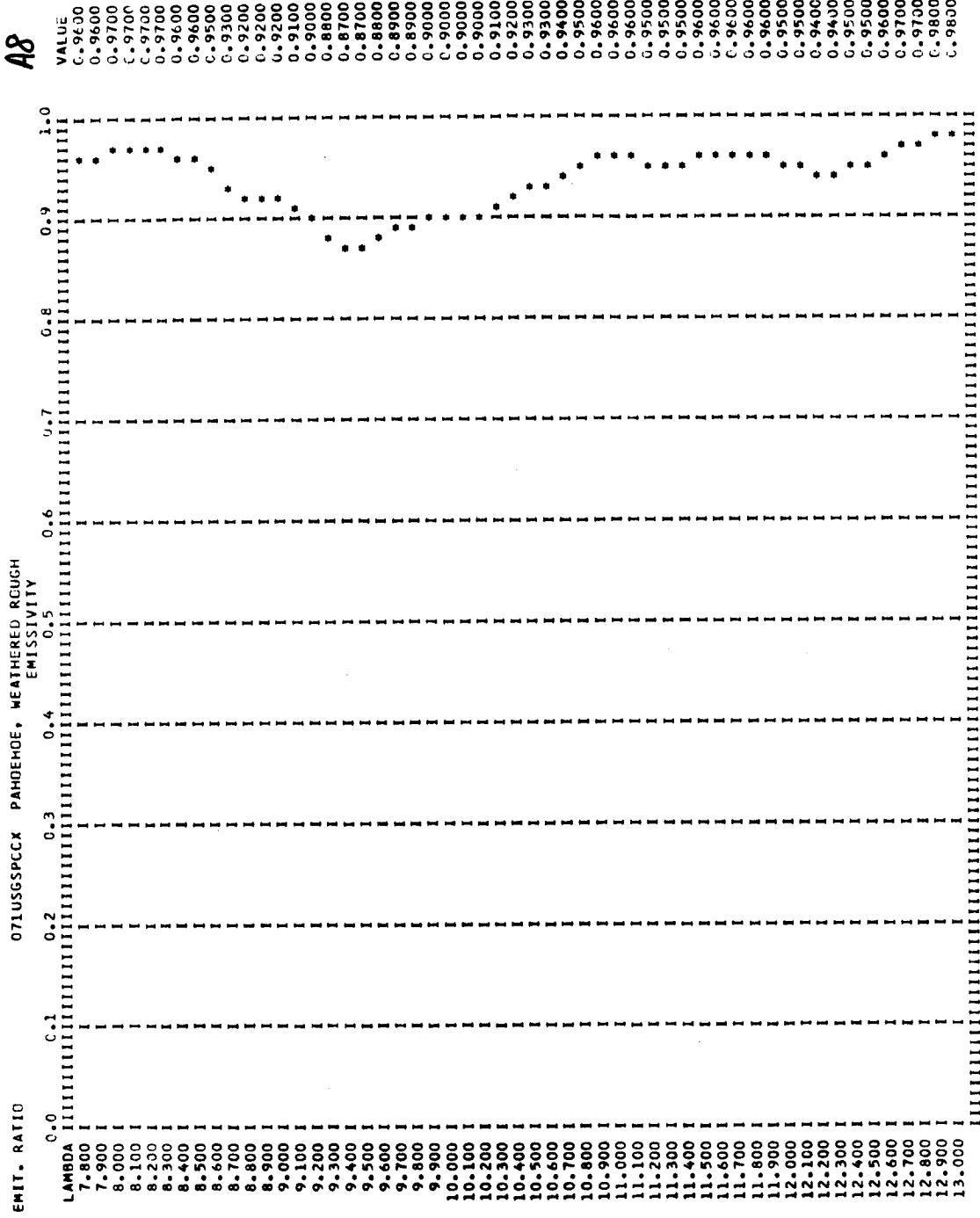
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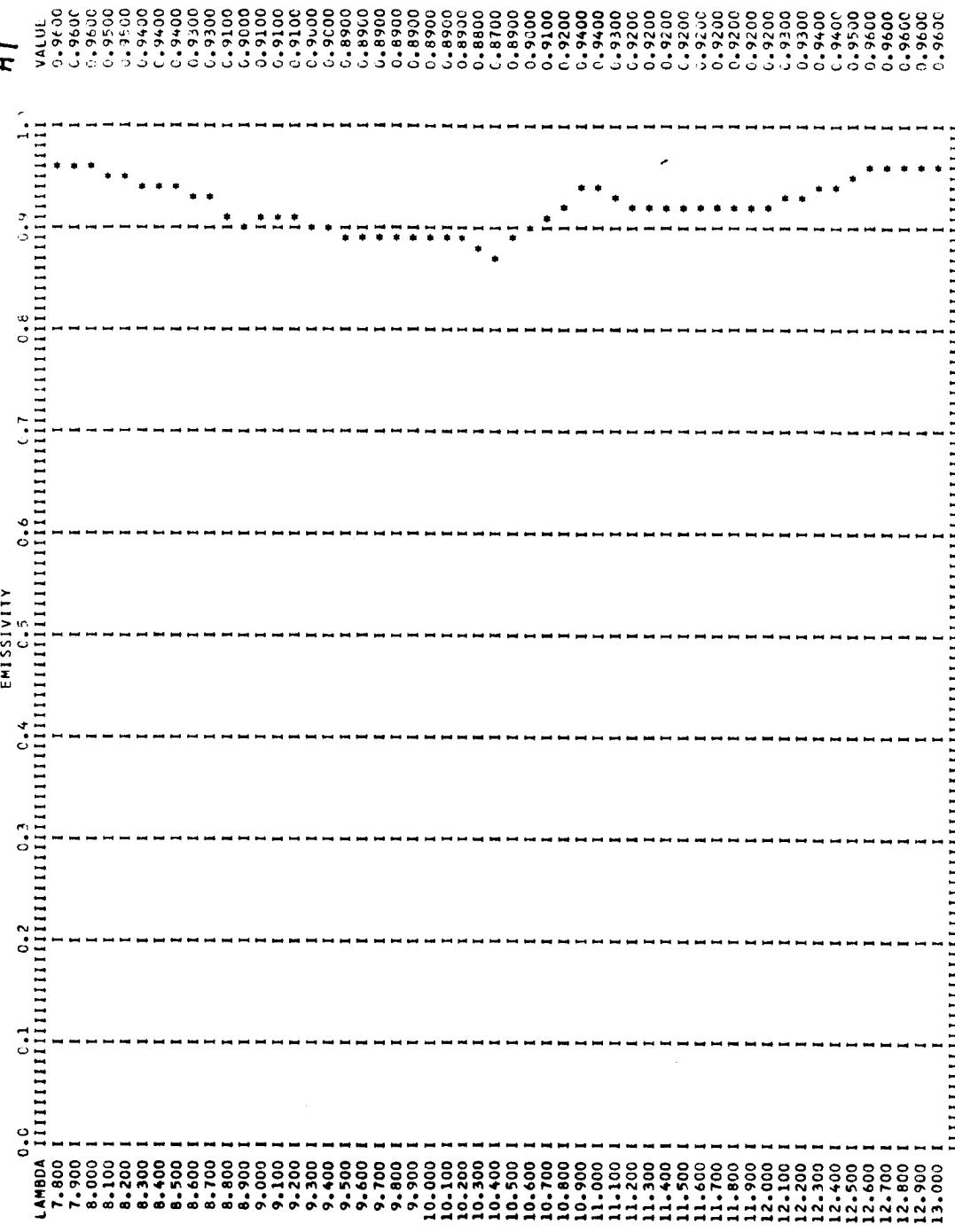


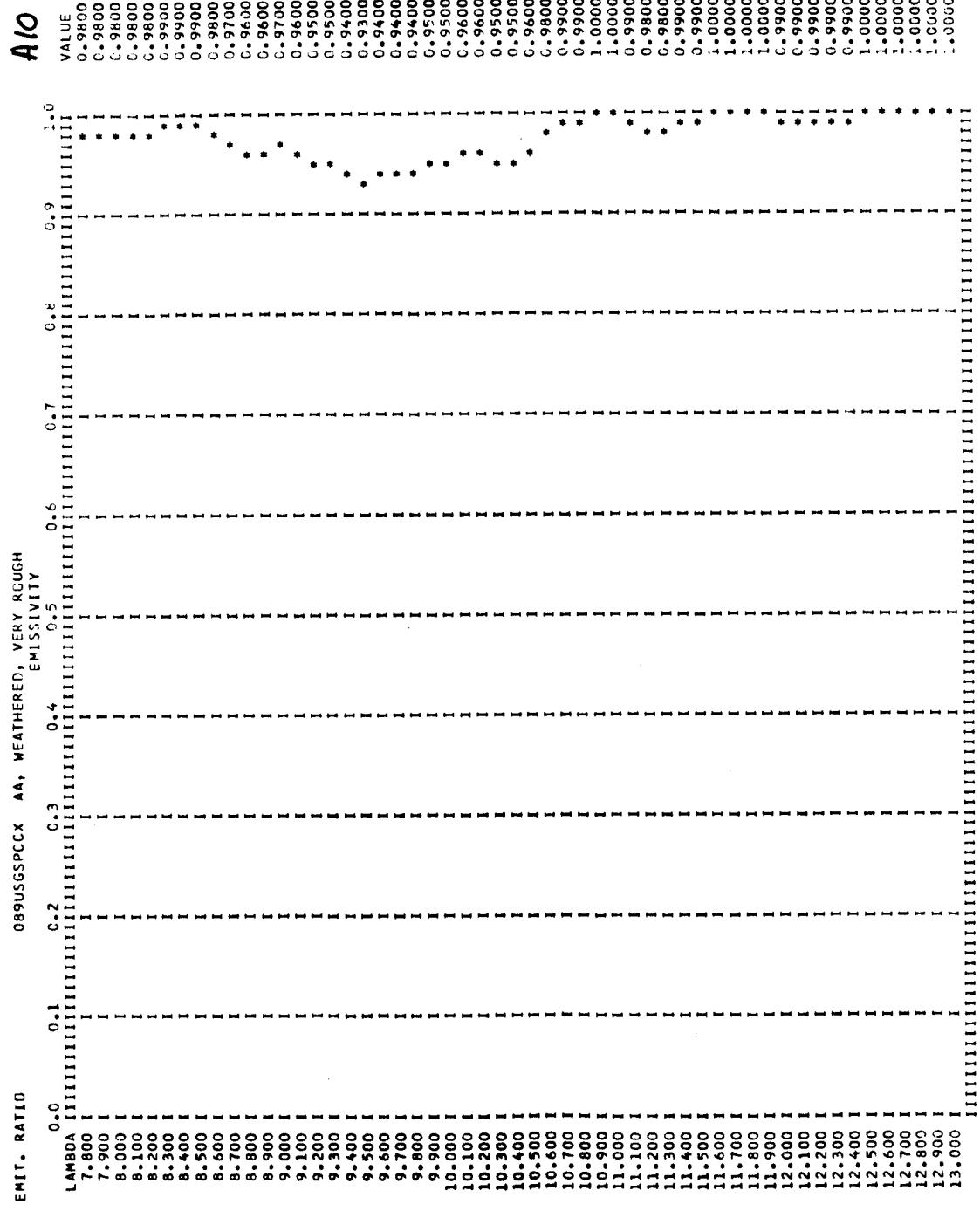
A8

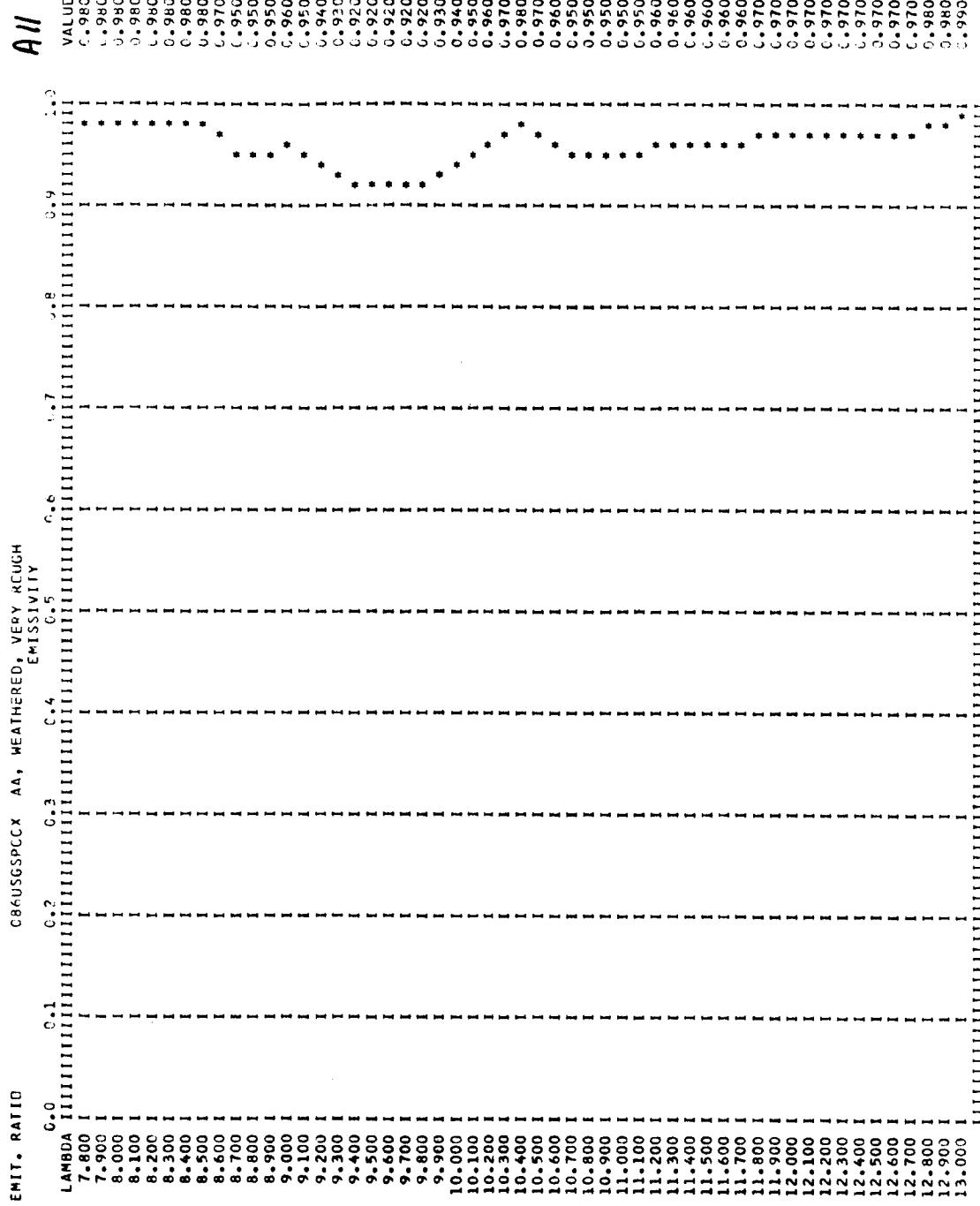


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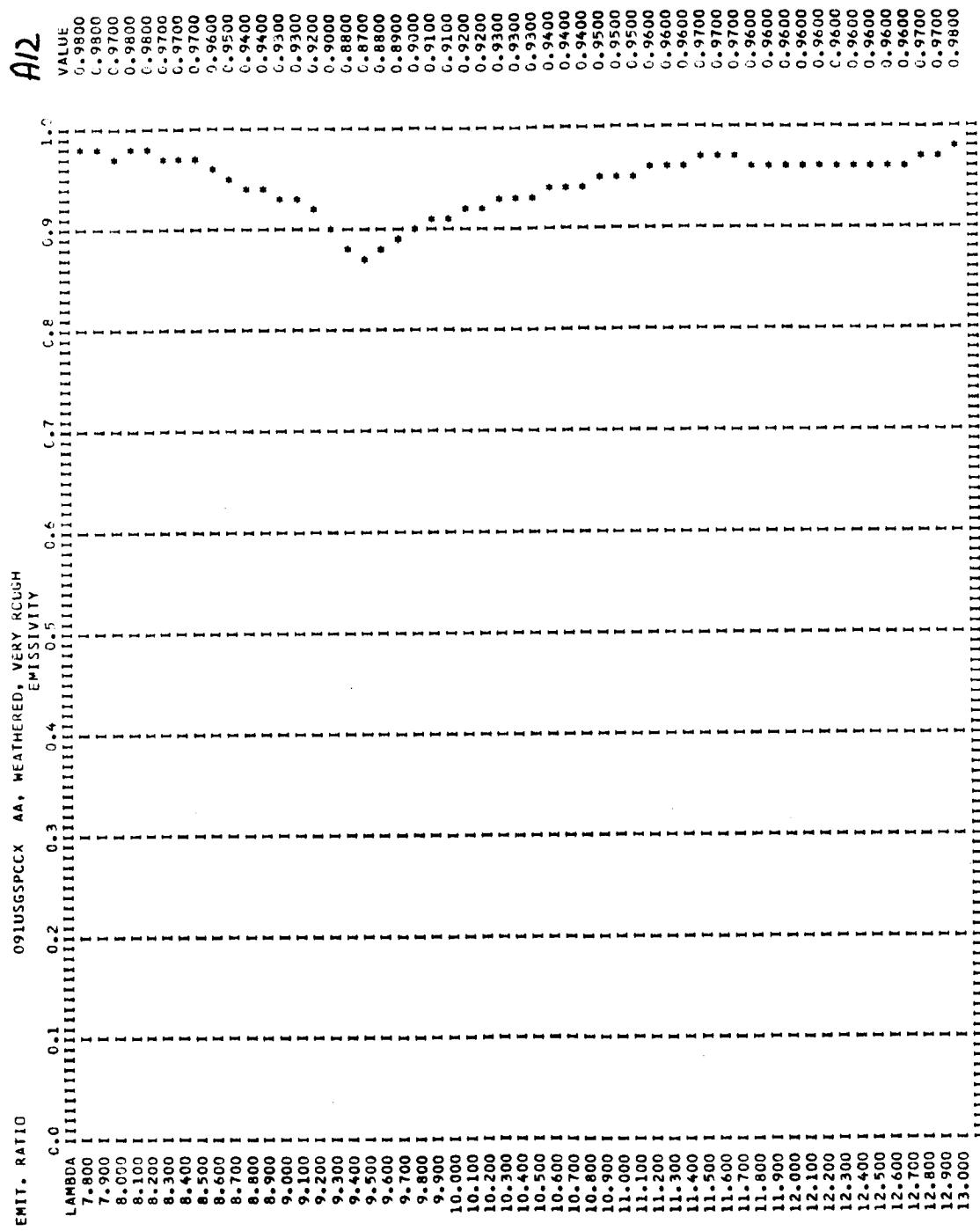
072USGSPCCX PAHOEHO, SAMED

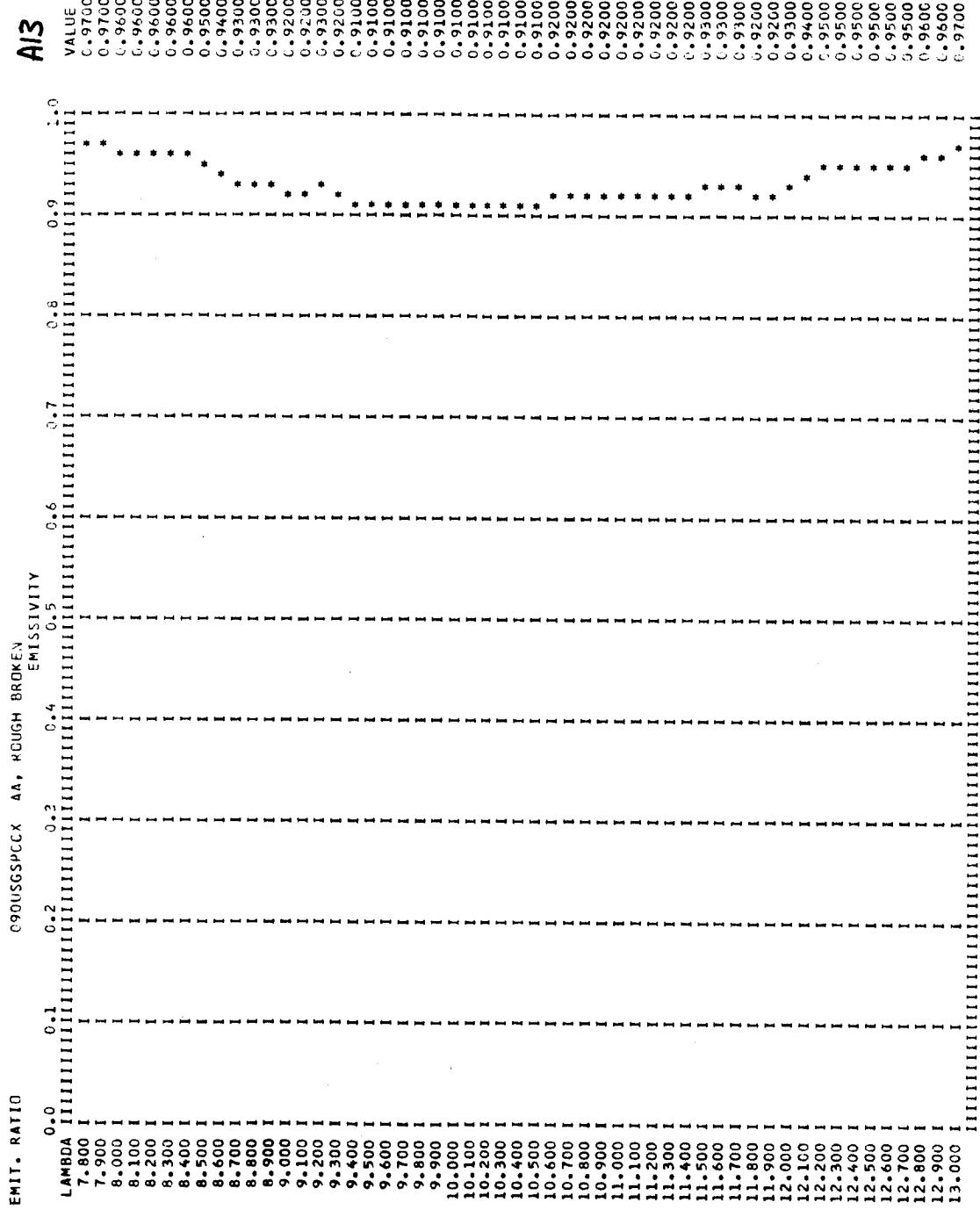






A12





STANFORD SPECTRAL CORRELATION PROGRAM

6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67

NEWLIB:= -L
 NUMBER OF LIBRARY SPECTRA= 19
 NUMBER OF SPECTRAL POINTS= 53
 (340,714,15,JAC)

CARD INPUT
 LATA(1)= 7.8000
 NPTS=****

WAVELENGTHS OF THE INPUT DATA AND THE LIBRARY

TAPE	LIBRARY
7.6000	7.8000
7.9000	7.9000
8.0000	8.0000
8.1000	8.1000
8.2000	8.2000
8.3000	8.3000
8.4000	8.4000
8.5000	8.5000
8.6000	8.6000
8.7000	8.7000
8.8000	8.8000
8.9000	8.9000
9.0000	9.0000
9.1000	9.1000
9.2000	9.2000
9.3000	9.3000
9.4000	9.4000
9.5000	9.5000
9.6000	9.6000
9.7000	9.7000
9.8000	9.8000
9.9000	9.9000
10.0000	10.0000
10.1000	10.1000
10.2000	10.2000
10.3000	10.3000
10.4000	10.4000
10.5000	10.5000
10.6000	10.6000
10.7000	10.7000
10.8000	10.8000
10.9000	10.9000
11.0000	11.0000
11.1000	11.1000
11.2000	11.2000
11.3000	11.3000
11.4000	11.4000
11.5000	11.5000
11.6000	11.6000
11.7000	11.7000
11.8000	11.8000
11.9000	11.9000

USGS Spectra
Bentley Point- 360 Intensity Program
 19 Rock library
 CORRCF
 (Correlation Coefficient
 program)

: Reference: See SRSL Report 67-1

B/

12.9000
12.1000
12.2000
12.3000
12.4000
12.5000
12.6000
12.7000
12.7000
12.8000
12.9000
13.0000

B2

83
 Q73 USGSAC STATISTICAL INFORMATION 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
 $\epsilon(\lambda)$ BARR = 0.84679 VARIANCE E(λ) $\Delta\lambda$) = 0.00523

LIBRARY SPECTRA		CORRELATION COEFFICIENT	CO-VARIANCE
R-YULITE PUMICE	(Y FROTHY)	RYPMCE	0.97471 0.00269
GESSIAN - 34%		OBS104	0.97379 0.00297
PYRUX APLITE		PYXAPL	0.91610 0.00368
WELLED TUFF	(INTS-RAINIER)	WLDTUF	0.90890 0.00221
GRANIT. RUGGH		GNTRUF	0.88058 0.00576
NEPHELINE SYENITE		NESYEN	0.86656 0.00432
AUG. DICRITÉ ROUGH		AGD10R	0.83968 0.00314
QUARTZ BEACH SAND		OBSAND	0.75936 0.00369
ANDESITE		ANDSIT	0.75734 0.00171
K-FEUDSPAR POLUGH	CLEAVAGE	KSPARF	0.75083 0.00533
HYP. ANDES		HYPAND	0.72549 0.00194
QUARTZ CIRRITE		QZD10R	0.67442 0.00228
KASALT		BASALT	0.61129 0.00127
SERPENTINE	STD.	SERPTN	0.45038 0.00190
POLYSTYRENE		POLYSY	0.13705 0.00169
CALCITE		CLCITE	0.11281 0.00027
PERDOTTITE SAWN		PERDTE	0.04810 0.00019
FARMINGTON METEOR-ITE		MTRITE	-0.14439 -0.00066
LLUNITE ROUGH		DUNITE	-0.23573 -0.00113

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074 USGS/C STATISTICAL INFORMATION 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
CX ORSIDIAN, BLACK, SMOOTH F(LAMBDA) BAR= 0.84925 VARIANCE F(LAMBDA)= 0.00791

LIBRARY SPECTRA		CORRELATION COEFFICIENT	CO-VARIANCE
RHYOLITE PUMICE	IV FROTHY	RYPMCE	0.98276 0.00334
CFSIDIAN - 3424		OBSID4	0.97598 0.00366
PYROX APLITE		PYAPL	0.93434 0.00462
WELDED TUFF (ANTS-RAINIER)		WLDTUF	0.91480 0.00274
GRANITE ROUGH		GNTRUF	0.88296 0.00711
NEPHELINE SYENITE		NESEVN	0.87963 0.00540
AUG. DICRITE ROUGH		AGDOR	0.86226 0.00396
ANDESITE		ANDSIT	0.78565 0.00219
K-FELDSPAR ROUGH CLEavage		KSPARF	0.76315 0.00667
HYP. ANDES		HYPAND	0.76198 0.00251
QUARTZ BEACH SAND		QBSAND	0.74847 0.00448
QUARTZ DICRITE		QD2IOR	0.70558 0.00293
BASALT		BASALT	0.65817 0.00168
SERPENTINE		SERPNT	0.49114 0.00255
CALCITE		CLCTE	0.13289 0.00039
POLYSTYRENE STD.		POLYSY	0.13043 0.00198
PERIDOTITE SAWN		PERDTE	0.09338 0.00044
FARMINGTON METEOR-ITE		MTRITE	-0.09025 -0.00051
DUNITE ROUGH		DUNITE	-0.17652 -0.00104

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LIBRARY SPECTRA	CORRELATION COEFFICIENT	CO-VARIANCE
RHYOLITE PUMICE (V FROTHY)	0.90145	0.00110
CSIDIAN - 3424	0.8295	0.00112
HYP. ANCE,	0.8042	0.00095
WELDED TUFF (INTS-PAINTER)	0.7904	0.00085
AUG. DIORITE ROUGH	0.7895	0.00130
PYROX APLITE	0.7833	0.00139
BASALT	0.7412	0.00068
NEPHELINE SYENITE	0.7368	0.00162
K-FELDSPAR ROUGH CLEAVAGE	0.7324	0.00229
GRANITE ROUGH	0.7230	0.00208
ANDESITE	0.6442	0.00064
CLARTZ DIOURITE	0.6330	0.00094
QUARTZ BEACH SAND	0.5945	0.00119
SERPENTINE	0.4404	0.00082
FARMINGTON METEOR-ITE	0.2561	0.00052
CALCITE	0.2502	0.00026
PERODITE SAWN	0.2048	0.00035
POLYSTYRENE STD.	0.07327	0.00040
DUNITE ROUGH	0.07132	0.00015

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U75 USGS/C STATISTICAL INFORMATION 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
CX RHYOLITE PUMICE, WEATHERED ROUGH E(LAMBDA) BAR= 0.86321 VARIANCE E(LAMBDA)= 0.00300

LIBRARY SPECTRA	CORRELATION COEFFICIENT	CO-VARIANCE
RHYOLITE PUMICE	0.94845	0.00199
(PSIDIAN - 34.24	0.91404	0.00211
MELDED TUFF (NTS-RAINIER)	0.90583	0.00167
PYROX APLITE	0.89332	0.00272
GRANITE ROUGH	0.85714	0.00425
NEPHELINE SYENITE	0.79628	0.00301
AUG. DIORITE ROUGH	0.77978	0.00221
QUARTZ BEACH SAND	0.73956	0.00272
ANDESITE	0.70207	0.00120
HYPAND	0.69786	0.00141
K-FELDSPAR	0.66719	0.00360
QUARTZ DICRITE	0.63067	0.00161
BASALT	0.56483	0.00092
SERPENTINE	0.40188	0.00128
CLCITE	0.13015	0.00023
PERIDOTITE SAWN	0.06937	0.00003
POLYSTYRENE STD.	-0.03950	-0.00037
FARMINGTON METEOR-ITE	-0.15522	-0.00054
DUNITE ROUGH	-0.26405	-0.00096

U79 USGS/CX STATISTICAL INFORMATION, 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
 E(LAMBDA) = 0.92868 VARIANCE E(LAMBDA) = 0.00125

LIBRARY SPECTRA	CORRELATION COEFFICIENT	CO-VARIANCE
KELLED TUFF (NTS-RAINIER)	WLDTUF	0.35997
KYANITE PUMIC- (IV FROTHY)	ZYPERC	0.94625
PYROX APLITE	DYXAPL	0.94312
GRANITE RUGH	GATKUF	0.92634
LE SILIAN - 34-24	CHSIDA	0.91986
NE PHENLINE SYENITE	MESYEN	0.81708
QUARTZ BEACH SAND	QBSAUC	0.79577
ALG. DICRITTE RUGH	AGDIOU	0.77933
ANDESITE	ANDSIT	0.71085
HYP. ANLES	HYPANC	0.67389
K-FELDSPAR RUGH	KSPARF	0.61613
QUARTZ CIR RITE	QDIOU	0.58424
BASALT	HASALT	0.55584
SERPENTINE	SERPTN	0.33768
CALCITE	GLCITE	0.14394
PLYSTYRENE STD.	PULSY	0.02406
PERIDOTITE SAk	PEROTE	-0.07292
FARMINGTON METEOR-ITE	MTRITE	-0.15343
DUNITE RUGH	DUNITE	-0.23727

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OFC USGS/CX STATISTICAL INFORMATION 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67

E(LAMBDA) BAR= 0.91132 VARIANCE E(LAMBDA)= 0.00094

LIBRARY SPECTRA	CORRELATION COEFFICIENT	CO-VARIANCE
RHYOLITE PUMICE (V FROTHY)	0.96323	0.00113
LFSIDIAN ~ 34.74	0.91865	0.00119
WELDED TUFF (INTS-RAINIER)	0.89096	0.00092
PYROX APLITE	0.87775	0.00150
GRANITE ROUGH	0.84889	0.00236
CLARTZ BEACH SAND	0.76965	0.00159
NEPHELINE SYENITE	0.76461	0.00162
AUG. DIORITE ROUGH	0.76072	0.00121
FYP. ANDES	0.69334	0.00079
K-FELDSPAR ROUGH CLEAVAGE	0.66928	0.00202
ANDESITE	0.65398	0.00063
BASALT	0.57605	0.00051
QUARTZ DIORITE	0.57370	0.00082
SERPENTINE	0.36227	0.00065
POLYSTYRENE STD.	0.04035	0.00021
CALCITE	0.02548	0.00003
FERDUTITE SAND	-0.00904	-0.00001
FARMINGTON METEOR-ITE	-0.13974	-0.00027
DUNITE ROUGH	-0.23305	-0.00047

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67P USGS MC STATISTICAL INFORMATION 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
CX QUARTZ MONZONITE, WEATHERED λ (LAMBDA) BAR = 0.90321 VARIANCE E (LAMBDA) = 0.00312

LIBRARY SPECTRA	CORRELATION COEFFICIENT	CO-VARIANCE
PYROX APLITE	0.97615	0.00303
KLLIEC TUFF (JTS-RAMIER)	0.95541	0.00179
GRANITE RUGH	0.95240	0.00481
ULSIDIAN - 34.2*	0.93713	0.00221
RHYOLITE PUMICE (V FROTHY)	0.93323	0.00199
NEPHELINE SYENITE	0.87642	0.00338
QUARTZ PEACH SAND	0.82726	0.00311
AUG. CICRITE RUGH	0.81515	0.00235
ANDFITE	0.74260	0.00130
HYPARAL	0.67427	0.00139
QUARTZ CLIRIT	0.63690	0.00166
K-FELDSPAR RUGH	0.62972	0.00345
KSPARF	0.55855	0.00089
BASALT	0.36698	0.00119
SERPENTINE STD.	0.16879	0.00100
POLYSTYRENE	0.16425	0.00030
CALCITE	-0.04084	-0.00012
PERIDOTITE SAN	-0.17247	-0.00061
FARMINGTON NEFLIR-ITE	-0.22700	-0.00084
DUNITE RUGH		

071 USGS Cx STATISTICAL INFORMATION 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
 Cx PAHOEHOE, WEATHERED ROUGH E(LAMBDA) = 0.00093
 (LAMBDA) BAK = 0.93774 VARIANCE E(LAMBDA) = 0.00093

LIBRARY SPECTRA	CORRELATION COEFFICIENT	CO-VARIANCE
K-FLUSSPAR ROUGH CLEAVAGE	0.93757	0.00280
AUG. DICRITITE ROUGH	0.90176	0.00142
QUARTZ CRYTRITE	0.86628	0.00123
ANDESITE	0.85136	0.00081
NEPHELINE SYENITE	0.83913	0.00176
CPSIDIAN - 3424	0.83738	0.00107
HYPAND	0.80312	0.00090
RHYOLITE PUMICE (W FROTHY)	0.78494	0.00091
SERPENTINE	0.77960	0.00138
BASALT	0.73355	0.00064
PYROX APLITE (NFS-RAINIER)	0.68144	0.00115
WELDED TUFF	0.62370	0.00064
GRANITE ROUGH	0.56547	0.00156
PERIDOTITE SAWN	0.45526	0.00074
QUARTZ BEACH SAND	0.29048	0.00059
FARMINGTON METEOR-ITE	0.16255	0.00031
CALCITE	0.15381	0.00016
DUNITE ROUGH	0.12429	0.00025
POLYSTYRENE STD.	0.07589	0.00039

LIBRARY SPECTRA		STATISTICAL INFORMATION		USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67		$\Sigma (\text{LAMBDA}) \text{ BAR} = 0.92208$		VARIANCE E(LAMBDA) = 0.00063	
QUARTZ DIORITE	ANALYST	CORRELATION COEFFICIENT	CO-VARIANCE	ANALYST	CORRELATION COEFFICIENT	CO-VARIANCE	ANALYST	CORRELATION COEFFICIENT	CO-VARIANCE
LA SALT	ANALYST	0.88341	0.00104	ANALYST	0.87021	0.00063	ANALYST	0.86635	0.00127
SERPENTINE	ANALYST	0.86635	0.00080	ANALYST	0.86182	0.00080	ANALYST	0.84943	0.00210
HYP. ANDES	ANALYST	0.86182	0.00108	ANALYST	0.83228	0.00108	ANALYST	0.78797	0.00162
K-FELDSPAR ROUGH CLEAVAGE	ANALYST	0.83228	0.00122	ANALYST	0.70374	0.00091	ANALYST	0.67633	0.00091
AUG. DIORITE ROUGH	ANALYST	0.83228	0.00068	ANALYST	0.64033	0.00068	ANALYST	0.62195	0.00060
ANDESITE	ANALYST	0.78797	0.00078	ANALYST	0.55861	0.00078	ANALYST	0.47556	0.00040
NEPHELINE SYENITE	ANALYST	0.70374	0.00074	ANALYST	0.46589	0.00074	ANALYST	0.39560	0.00066
PERIQUOTITE SAW	ANALYST	0.67633	0.00075	ANALYST	0.37272	0.00065	ANALYST	0.22352	0.00018
LFSLICIAN - 34.24	ANALYST	0.64033	-0.00007	ANALYST	0.04322	0.00018	ANALYST	0.04322	-0.00007
RHYOLITE PUMICE (W FROTHY)	ANALYST	0.62195	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025
PYRUX APLITE	ANALYST	0.55861	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025
WELDED TUFL (NTS-MAINER)	ANALYST	0.47556	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025
FARMINGTON METEIR-TTF	ANALYST	0.46589	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025
DUNITE ROUGH	ANALYST	0.39560	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025
GRANITE ROUGH	ANALYST	0.37272	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025
CALCITE	ANALYST	0.22352	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025
QUARTZ PEACH SAND	ANALYST	0.04322	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025
POLYSTYRENE STL.	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025	ANALYST	-0.05832	-0.00025

B/2

089 USGS PC STATISTICAL INFORMATION 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
CX AA, MEASURED, VERY ROUGH ELLAMBDAL BARR = 0.97698 VARIANCE ELLAMBDAL = 0.00043

LIBRARY SPECTRA	CORRELATION COEFFICIENT	CO-VARIANCE
ANDESITE	ANDSIT	0.90506
NEPHELINE SYENITE	NESYEN	0.88059
AUG. DIORITE ROUGH	AGDOR	0.85847
K-FELDSPAR RUGGED CLEAVAGE	KSPARF	0.84430
LFSIOLAN - 34.4	OBSID4	0.83997
QUARTZ DIORITE	QZDOR	0.83564
RHYOLITE PUMICE (W FROTHY)	RYPCE	0.75924
PYROX ALPLITE	PYAPL	0.73038
SERPENTINE	SERTN	0.70680
WELDED TUFF (JTS-RAINIER)	MLDTUF	0.69247
HYP. ANCS	HYPAND	0.68715
GRANITE ROUGH	GTRUF	0.65242
HASALT	BASALT	0.62074
QUARTZ BEACH SAND	QBSAND	0.61464
PERIOTITE SAWN	PEROTE	0.31548
CALCITE	CLCITE	0.27950
POLYSTYRENE STD.	POLYSY	0.12545
FARMINGTON METEUR-ITE	MIRITE	0.08859
DUNITE ROUGH	DUNITE	-0.02624

B/3

C.C. USGS PC STATISTICAL INFORMATION 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
CX AA, WEATHERED, VERY ROUGH E(LAMBDA) BAR= 0.95962 VARIANCE E(LAMBDA)= 0.00035

LIBRARY SPCTRA	CORRELATION COEFFICIENT	CD-VARIANCE
K-FELDSPAR RUGGH CLEAVAGE	KSPAPF	0.87420
AUG. DICRITTE DUSH	ASOLUR	0.79788
HYP. ANDES.	HYPAND	0.75272
QUARTZ DURRIT	QDUR	0.71271
BASALT	BASALT	0.71218
NEPHELINE SYENITE	NESYEN	0.69500
ANDESITE	ANOSIT	0.69056
LGSILIAN - 344	OBSIDS	0.68508
RHYOLITE PUMICE	RYPMC	0.67119
SERPENTINE	SERPNT	0.66433
PYROX APLITE	PYXPL	0.53651
WFLDO TUFF (INTS-RAINIER)	WLTUFF	0.49633
PERLITE SAH	PERLITE	0.45221
GRANITE RUGGH	GTRUF	0.42155
FARMINGTON METER-ITE	MIRITE	0.37893
LINITE RUGGH	DUNITE	0.29019
QUARTZ BEACH SAND	QSAND	0.14650
POLYSTYRENE STD.	POLYSY	0.11569
CALCITE	CLCITE	0.10121

B/4

L+I USGSPC CX XA, WEATHERED, VERY ROUGH 6-10-67 USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-67
E(LAMBDA) BAR= 0.94566 VARIANCE E(LAMBDA)= 0.00080

LIBRARY SPECTRA	CLEAVAGE	CORRELATION COEFFICIENT	CO-VARIANCE
K-FELDSPAR RILGH	KSPARF	0.97121	0.00270
AUG. DIGRITITE ROUGH	AGDOR	0.90931	0.00133
QUARTZ DIOGRITE	OZDOR	0.84156	0.00111
FYP. ANDES.	HYPAND	0.83341	0.00087
SERPENTINE	SERPTN	0.83240	0.00137
ANDESITE	ANDISIT	0.83100	0.00074
NEPHELINE SYENITE	NEYEN	0.81159	0.00159
QESIGIAN - 3424	OBSDK	0.80063	0.00096
BASALT	RASALT	0.78232	0.00064
RHYOLITE PUMICE (W FROTHY)	RYPCE	0.74495	0.00081
PYROX APLITE	PYXPL	0.63679	0.00100
PERICOTITE SAHN	PERDTE	0.54428	0.00082
HELD TUFF (NTS-RAMIER)	HELTUF	0.54393	0.00052
GRANITE ROUGH	GNTRUF	0.48159	0.00123
DUNITE ROUGH	DUNITE	0.27133	0.00051
FARMINGTON METEOR-ITE	MIRITE	0.27005	0.00048
QUARTZ BEACH SAND	QBSAND	0.21380	0.00041
POLYSTYRENE STD.	POLYSY	0.20984	0.00101
CALCITE	CLCITE	0.06734	0.00006

B15

USGS DATA RUN WITH 19 SPECTRUM ROCK LIBRARY OF 6-9-7
 $\epsilon(\lambda)$ (LAMBDA) BAR = 0.93208 VARIANCE E(LAMBDA) = 0.00039

LIBRARY SPECTRA	STATISTICAL INFORMATION	CORRELATION COEFFICIENT	CO-VARIANCE
LASALT	RASALT	0.91016	0.00051
HYP. AMITE	HYP-MD	0.87241	0.00063
SERPENTINE	SERITN	0.83343	0.00095
K-FELDSPAR RUGH CLEAVAGE	KSPARF	0.81406	0.00157
QUARTZ CLAYITE	QZCLAY	0.7930	0.00073
PERIDOTITE SAW	PERETE	0.77980	0.00082
AUG. DICRITITE RUGH	AGDLTR	0.75583	0.00077
FARMINGTON METEGR-TITE	MTRITE	0.70569	0.00088
ANDESITE	ANOSIT	0.64976	0.00040
DUNITE RUGH	DUNITF	0.61211	0.00080
NEPHELINE SYENITE (W FRATHY)	NESYEN	0.56010	0.00076
RHYOLITE PUMICE	RYPICE	0.52026	0.00039
LF SIDIAN - 34.4	OBSIDN	0.49382	0.00041
PYRUX APLITE	PYXAPL	0.40325	0.00044
WELLW TUFF (INTS-RAVIER)	MLDTUF	0.32564	0.00022
GRANITE RUGH	GNTRUF	0.19945	0.00035
CALCITE	CLCITE	0.19688	0.00013
POLYSTYRENE STD.	POLSY	-0.01444	-0.00005
QUARTZ REACH SA 40	QBSAND	-0.12706	-0.00017

BMD02R - STEPWISE REGRESSION - VERSION OF APR. 9, 1964
HEALTH SCIENCES COMPUTING FACILITY, UCLA

PROBLEM #	CASES	SURVEY
NUMBER OF	12	
NUMBER OF ORIGINAL VARIABLES	18	
NUMBER OF VARIABLES ACCED	-C	
TOTAL NUMBER OF VARIABLES	18	
NUMBER OF SUB-PROBLEMS	13	

MODAL ANALYSIS
PROGRAM . T

(STANFORD
TRAINING SET USED)

VARIABLE	MEAN	STANDARD DEVIATION	USGS#
1	0.79250	0.83093	
2	0.77917	0.81796	
3	0.90583	0.94651	
4	0.82583	0.86453	
5	0.90417	0.94491	
6	0.88917	0.92322	
7	0.86333	0.90369	
8	0.91167	0.95258	
9	0.90167	0.94193	
10	0.96083	1.00376	
11	0.94563	0.98807	
12	0.92000	0.96119	
13	0.91667	0.95746	
QUARTZ	14	1093.33333	1155.26350
ORTHOIC	15	984.50000	1033.62321
PLAGIO	16	696.91666	729.25510
OLIVIN	17	828.83333	870.33337
OTHER	18	823.50000	860.61447

NOT NORMALIZED

			ROCK TYPE	
			Mono Lake, California	
			Obsidian, grey	
			Obsidian, black	
			Rhyolite pumice, weathered	
			Rhyolite pumice, weathered	
			Bishop Tuff (upper)	
			Bishop Tuff (lower)	
			Quartz Monzonite, weathered	
			Pisgah Crater, California	
			Bassalt, pahoehoe, weathered	
			Bassalt, pahoehoe, sawed	
			Bassalt, aa, weathered	
			Bassalt, aa, weathered	
			Bassalt, aa, weathered	
			Bassalt, aa, rough	

OBSIDIAN, GEM
USGS 073

C4
(pages C2, 3 omitted)

SUB-PROBLEM 1
DEPENDENT VARIABLE 1
MAXIMUM NUMBER OF STEPS 16
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.9994
STD. ERROR OF EST. 0.0355

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	8.275	8.275	8877.431
RESIDUAL	11	0.010	0.001	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
{CONSTANT	0.	)	0.00001	8877.4307	2	0.91758	0.0015
ORTHO15	0.000080			3	0.52760	0.0059	53.2709
				4	0.90529	0.0058	3.5573
				5	0.66649	0.0053	45.6188
				6	0.64109	0.0052	7.1808
				7	0.71196	0.0037	6.9777
				8	0.56682	0.0070	10.2793
				9	0.62001	0.0106	5.2221
				10	0.59863	0.0082	6.2446
				11	0.45515	0.0081	5.5651
				12	0.51565	0.0076	2.6130
				13	0.53901	0.0105	3.6220
				QUARTZ	0.48020	0.0205	4.0951
				PLAGIO	0.4217	0.0124	2.9970
				OLIVIN	0.49863	0.0242	2.5700
				OTHER	0.60946	0.0120	2.0145
						5.9093	

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL	—	—
1	0.00641	7	-0.00662
2	-0.01306	8	-0.03084
3	-0.00575	9	-0.04053
4	0.06567	10	-0.01776
5	0.01774	11	-0.01269
6	0.01195	12	0.02670

OBSIDIAN Black

C5 USGS 074

SUB-PROBL^M 2
 DEPENDENT VARIABLE 2
 MAXIMUM NUMBER OF STEPS 1C
 F-LEVEL FOR INCLUSION 6.000000
 F-LEVEL FOR DELETION 4.000000
 TOLERANCE LEVEL 0.000100

STEP NUMBER 1

VARIABLE ENTERED 15

MULTIPLE R 0.9993
 STD. ERROR OF EST. 0.0329

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	8.017	8.017	7415.273
RESIDUAL	11	0.012	0.001	

VARIABLES IN EQUATION

VARIABLE COEFFICIENT STD. ERROR F TO REMOVE

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CCRR.	TOLERANCE	F TO ENTER
CONSTANT	0.						
ORTHOC	0.000079	0.00001	7415.2731	1	0.91758	0.00112	73.2709
				3	0.20291	0.0059	0.0294
				4	0.76760	0.00398	14.3629
				5	0.35510	0.0053	1.4449
				6	0.34195	0.0052	1.3241
				7	0.44313	0.0037	2.4434
				8	0.26486	0.0070	0.7146
				9	0.30728	0.0106	1.0426
				10	0.27879	0.0082	0.8428
				11	0.10998	0.0081	0.1224
				12	0.17405	0.0076	0.3124
				13	0.22415	0.0105	0.4349
				14	0.54409	0.0205	4.2053
				PLAGIO	0.13960	0.0124	0.1988
				CLIVIN	0.010313	0.0242	0.075
				OTHER	0.33191	0.0120	1.2381

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL	9	-0.03668
1	-0.01174	10	-0.01380
2	-0.03169	11	0.02648
3	-0.01480	12	0.05044
4	0.05580		
5	0.01910		
6	0.00403		
7	-0.00393		
8	-0.03533		

RHYOLITE PUMICE
VS95 085

C 6

SUB-PROBLEM 3
DEPENDENT VARIABLE 3
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.00100

STEP NUMBER 1
VARIABLE ENTERED 16

MULTIPLE R 0.9975
STD. ERROR OF EST. 0.0701

ANALYSIS OF VARIANCE
REGRESSION DF 1 SUM OF SQUARES 10.696 MEAN SQUARE 10.696 F RATIO 2174.419
RESIDUAL 11 0.054 0.005

VARIABLES IN EQUATION						VARIABLES NOT IN EQUATION					
VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER				
(CONSTANT)	c. 0.00129	c. 0.00003	2174.4193	1	0.76008	0.0101	13.6812				
PLAGIO 16	0.72148	0.0127		2	0.83420	0.0086	10.8563				
	0.96311	0.0053		4	0.97273	0.0052	22.8822				
	0.91954	0.0054		6	0.9054	0.0020	175.9191				
	0.95879	0.0020		7	0.7509	0.0020	54.7509				
	0.84316	0.0025		8	0.8717	0.0020	113.8717				
	0.94071	0.0024		9	0.5916	0.0025	24.5916				
	0.97223	0.0028		10	0.9028	0.0028	172.6073				
	0.97434	0.0020		11	0.97420	0.0020	187.4220				
	0.89546	0.0030		12	0.90204	0.0030	40.4658				
	0.90204	0.0392		13	0.72946	0.0124	43.6692				
QUARTZ 14	-0.83840	0.0028		14	0.83840	0.0028	11.3724				
GRTHOC 15	0.91601	0.0085		15	0.91601	0.0085	52.1421				
CLIVIN 17				16							
CTHER 18				17							

Rhyolite Pumice off

STEP NUMBER 2
VARIABLE ENTERED 14

MULTIPLE R 0.9995
STD. ERROR OF EST. 0.0318

ANALYSIS OF VARIANCE
REGRESSION DF 2 SUM OF SQUARES 10.740 MEAN SQUARE 5.370 F RATIO 5326.347
RESIDUAL 10 0.010 0.001

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VARIABLE	VARIABLES IN EQUATION	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	VARIABLES NOT IN EQUATION	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT	0.	0.00026	)	C.00004	43.6692	1	C.08993	C.0033	C.0734
QUARTZ 14	0.00026	0.00006	193.4936		2	-0.02759	0.0044	0.0069	
PLAGIO 16	0.00088				4	-0.13723	0.0069	0.1728	
					5	0.08882	0.0064	17.0256	
					6	0.85691	0.0065	24.8718	
					7	0.410C	0.0065	2.2980	
					8	0.16392	0.0062	-2.6125	
					9	0.26380	0.0066	0.6732	
					10	0.65598	0.0003	5.7989	
					11	C.9214C	C.0069	50.5955	
					12	0.66740	0.0044	27.3473	
					13	0.22998	0.0010	5.9224	
					14	0.29834	0.0062	0.8793	
					15	-0.5678	0.0098	1.3127	
					16	0.59190	0.0019	4.8534	
					OTHER 18				

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.0314
2	-0.00546
3	-0.0240
4	-0.0041
5	0.00345
6	0.01487
7	0.01356
8	0.03038
9	0.04580
10	-0.00469
11	-0.03862
12	-0.05214

C8

RHYOLITE PUMICE
USGS 075

SUB-PROBLEM 4
DEPENDENT VARIABLE 4
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL C.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.9981
STD. ERROR OF EST. 0.0556

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	8.935	8.935	2885.835
RESIDUAL	11	0.034	0.003	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.000083	)	0.00002	2885.8348			
ORTHOC	15			1	0.90529	0.0012	45.4188
				2	0.76160	0.0015	14.3429
				3	0.75118	0.0059	12.4871
				5	0.85762	0.0053	27.8090
				6	0.84652	0.0052	25.2856
				7	0.89694	0.0037	41.1499
				8	0.76159	0.0070	13.8108
				9	0.80436	0.0106	18.3285
				10	0.78119	0.0082	15.8655
				11	0.67394	0.0081	8.3215
				12	0.70630	0.0076	9.9546
				13	0.75127	0.0105	12.9573
				QUARTZ	1.4	0.62463	0.0205
				PLAGIO	1.6	0.55582	0.0124
				OLIVIN	1.7	0.4703	4.4703
				C'THER	1.8	0.83345	0.0242
						C.C120	22.7482

STEP NUMBER 2
VARIABLE ENTERED 14

MULTIPLE R 0.9988
STD. ERROR OF EST. 0.0456

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	8.948	4.474	2154.158
RESIDUAL	10	0.021	0.002	

C9

VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION			F TO ENTER
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CORR.	TOLERANCE	PARTIAL CORR.	
(CONSTANT)								
QUARTZ 14	0.00020	0.00008	6.3977	1	0.88373	0.0010	32.0905	
ORTHOCL 15	0.00061	0.00009	47.2856	2	0.62282	0.0010	6.6944	
				3	0.7161	0.0053	10.3657	
				5	0.8044	0.0043	21.6669	
				6	0.8332	0.0044	21.0600	
				7	0.89145	0.0031	37.2510	
				8	0.880102	0.0069	31.2139	
				9	0.87954	0.0101	30.7820	
				10	0.86316	0.0078	26.3055	
				11	0.7145	0.0079	14.6742	
				12	0.8338C	0.0075	26.5294	
				13	0.81119	0.0101	17.182	
				PLAGIO 16	0.89976	0.0119	38.2666	
				OLIVIN 17	0.94922	0.0214	67.355C	
				OTHER 18	0.75681	0.0086	12.0657	
STEP NUMBER 3								
VARIABLE ENTERED	17							
MULTIPLE R		0.9999						
STD. ERROR OF EST.		0.0165						
ANALYSIS OF VARIANCE								
REGRESSION	3	SUM OF SQUARES 8.966	MEAN SQUARE 2.989	F RATIO 10987.835				
RESIDUAL	9	0.002	0.000	0.000				
VARIABLES IN EQUATION								
VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	PARTIAL CORR.	F TO ENTER
(CONSTANT)	0.							
QUARTZ 14	0.00029	C.00003	87.8471	1	0.93641	0.0005	56.9717	
ORTHOCL 15	0.00026	0.00005	23.9261	2	0.66600	0.0009	11.6700	
OLIVIN 17	0.00031	0.00004	67.3550	3	-0.60434	0.0012	4.6030	
F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION								
LIST OF RESIDUALS								
CASE	RESIDUAL	9	-0.01220	11	-0.74461	0.0016	9.9554	
1	0.01317	10	-0.00515	12	-0.72236	0.0006	8.7293	
2	-0.01684	11	0.01741	13	-0.71278	0.0010	8.2620	
3	-0.01711	12	0.02849	PLAGIO 16	-0.40779	0.0014	1.9557	
4	0.00732	13		C.0016	-0.58637	0.0016	4.1919	
5	-0.00310	14		OTHER 18				
6	-0.00617	15						
7	0.00032	16						
8	-0.01012	17						

BISHOP TUFF (UPPER)
USGS 079

C/I/O

SUB-PROBLM 5
DEPENDENT VARIABLE 5
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.9974
STD. ERROR OF EST. 0.0716

ANALYSIS OF VARIANCE
REGRESSION DF 1
RESIDUAL 11

SUM OF SQUARES	MEAN SQUARE	F RATIO
10.658	10.658	2078.737
C.056	0.005	

VARIABLES IN EQUATION				VARIABLES NOT IN EQUATION			
VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
CONSTANT	0.00091	0.00002	2078.7370	1	0.64649	C.0012	7.1808
ORTHO 15				2	0.35210	0.0015	1.4429
				3	0.96329	0.0059	145.8668
				4	0.85162	0.0038	27.8090
				6	0.99210	0.0052	727.3207
				7	0.98222	0.0037	273.6718
				8	0.94200	0.0070	78.7824
				9	0.97050	0.0166	162.0275
				10	0.96500	0.0082	135.3923
				11	0.94252	0.0081	79.5655
				12	0.93827	0.0076	73.5771
				13	0.91655	0.0105	158.3139
				QUARTZ 14	0.41893	0.0205	2.1285
				PLAGIO 16	0.76708	0.0124	14.2959
				OLIVIN 17	0.67064	0.0242	8.1739
				CTHER 18	0.97453	0.0120	.88.8735

STEP NUMBER 2
VARIABLE ENTERED 16

MULTIPLE R 0.9989
STD. ERROR OF EST. 0.0482

ANALYSIS OF VARIANCE
REGRESSION DF 2
RESIDUAL 10

SUM OF SQUARES	MEAN SQUARE	F RATIO
10.691	5.346	2302.821
0.002	0.002	

CII

VARIABLE	VARIABLES IN EQUATION			VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE
{CONSTANT	C.00046	C.COC12	14.3761	1	0.52365	0.001C
ORTHO15	0.00065	C.COC17	14.2959	2	0.38041	1.6185
PLAGI16				3	0.91966	0.0024
				4	0.80863	0.0066
				6	0.98339	0.0021
				7	0.98634	0.0014
				8	0.97832	0.0009
				9	0.99216	0.0021
				10	0.98746	0.0115
				11	0.87934	0.0018
				12	0.91097	0.0010
				13	0.96028	0.0025
				QUART14	0.9467	C.C195
				CLIVIN17	-0.56165	C.C011
				OTHER18	0.91669	4.4474 0.0069
						181.4610

STEP NUMBER	VARIABLES ENTERED			VARIABLES NOT IN EQUATION		
	3	14				
MULTIPLE R	0.9998					
STD. ERR OF EST.	0.0193					

ANALYSIS OF VARIANCE						
		DF	SUM OF SQUARES	MEAN SQUARE	F RATIO	
REGRESSION	3	10.711	3.570	9547.327		
RESIDUAL	9	C.C03	0.000			

VARIABLE	VARIABLES IN EQUATION			VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE
{CONSTANT	C.00025	C.COC03	53.0737	1	-0.30118	C.C006
QUART14	C.00025	C.COC03	2.2990	2	-0.51256	0.6069
ORTHO15	C.0001C	C.COC03	115.3461	3	0.79152	0.009
PLAGI16	0.00075	0.00007		4	-0.22274	0.4004
				6	0.91598	0.0004
				7	0.64214	0.0001
				8	0.86308	0.0002
				9	0.948C8	0.0003
				10	0.9200C	0.0002
				11	0.79323	0.0069
				12	0.33116	0.0004
				13	0.90581	C.C008
				CLIVIN17	0.11748	36.5678
				OTHER18	0.86138	0.1120
						23.0048

C12

ANALYSIS OF VARIANCE		DF	SS
REGRESSION		2	
RESIDUAL		10	

MEAN SQUARE	F RATIO
5.355	12673.522
0.000	

VARIABLE	VARIABLES IN EQUATION			F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER	VARIABLES NOT IN EQUATION	
	COEFFICIENT	STD. ERROR	F TO ENTER							
(CONSTANT)	0.	1								
QUARTZ	0.00029	0.00003	123.9156		1	0.30233	C.0013	0.9054		
PLAGIO	0.00084	0.00004	421.2644		2	0.18848	0.0044	0.3315		
					3	0.80882	C.0009	17.3258		
					4	0.18307	0.0009	0.3121		
					6	0.93339	0.0009	60.8859		
					7	0.66867	0.0005	7.2786		
					8	0.87145	0.0002	28.4091		
					9	0.32613	0.0006	1.0712		
					10	0.68149	0.0003	7.8044		
					11	0.71888	0.0009	9.4255		
					12	0.89448	0.6004	36.0216		
					13	0.51738	0.0010	3.2898		
					15	0.45108	0.0062	2.2990		
					OLIVIN	-0.11628	0.0008	0.1234		
					COTHER	0.37010	0.0019	1.2825		

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

BISHOP TUFF (lower)
USGS 080

C13

SUB-PROBLEM 6
DEPENDENT VARIABLE 6
MAXIMUM NUMBER OF STEPS 1C
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.9974
STC. ERROR OF EST. 0.0698

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	1C.308	10.308	2114.722
RESIDUAL	11	0.054	0.005	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT)	C.000090	C.00002	2114.7224
ORTHOC 15			

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLES NOT IN EQUATION	PARTIAL CCRR.	TOLERANCE	F TO ENTER
(CONSTANT)	C.000090	C.00002	2114.7224				
ORTHOC 15				1	0.64109	0.00112	6.9777
				2	0.34195	0.00115	1.3241
				3	0.97696	0.00119	209.4968
				4	0.44652	0.00118	25.2856
				5	0.99320	0.00113	727.3207
				7	0.91418	0.00117	186.48C8
				8	0.94459	0.00110	82.8C53
				9	0.97042	0.0116	161.5468
				10	0.96565	0.00102	138.1177
				11	0.94857	0.00081	89.7783
				12	0.44219	0.00116	79.0672
				13	0.97640	0.0105	204.4049
				14	0.39297	0.0215	1.8263
				PLAGIC	0.7339	0.0124	14.8835
				CLIVIN	0.66383	0.C242	8.7835
				OTHER	0.97779	0.0120	217.6065

STEP NUMBER 2
VARIABLE ENTERED 16

MULTIPLE R 0.9990
STC. ERROR OF EST. 0.0464

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	1C.34C	5.170	2399.340
RESIDUAL	10	0.022	0.002	

C14

VARIABLE	VARIABLES IN EQUATION			F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
	COEFFICIENT	STD. ERROR	F TO REMOVE					
(CONSTANT)	0.	14.1903						
ORTHOC	0.00005	C.00012				0.51534	0.0010	3.2545
	0.00004	C.00016	14.8835			0.37775	0.0015	1.4533
PLAGIO	0.00004	C.00016				0.94239	0.0024	71.4283
						0.79064	0.0026	15.0069
						0.98339	0.0022	264.1825
						0.93458	C.0014	62.1126
						0.97568	0.0069	178.3457
						0.98283	0.0021	271.4886
						0.98087	0.0015	228.4711
						0.89152	0.0018	34.8609
						0.95412	0.0010	91.3767
						0.97522	0.0025	174.9054
						0.89004	0.0195	36.6609
QUARTZ	14					-0.51733	0.CC11	3.2889
OLIVIN	17					-0.51733	0.0669	315.9154
OTHER	18					0.98605		

STEP NUMBER	VARIABLE ENTERED	VARIABLES IN EQUATION			F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
		COEFFICIENT	STD. ERROR	F TO REMOVE					
3	14	0.9998	0.0217						
MULTIPLE R									
STD. ERROR OF EST.									

ANALYSIS OF VARIANCE			DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	3		10.357	3.452	7315.952	
RESIDUAL	9		C.004	0.000		

VARIABLE	VARIABLES IN EQUATION			F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
	COEFFICIENT	STD. ERROR	F TO REMOVE					
(CONSTANT)	0.	1	0.00004	36.6609	1	-0.22666	0.0006	0.4332
QUARTZ	14	0.00024			2	-0.44158	0.0009	1.9378
ORTHOC	15	0.00012	0.00008	2.4284	3	0.84932	0.0009	20.7095
PLAGIO	16	0.00074	0.00008	87.0745	4	-0.14646	0.0004	0.1754
					5	0.91598	0.C003	41.6934
					7	0.59908	0.0001	4.4785
					8	0.87010	0.0002	24.9320
					9	0.91639	0.0003	41.9279
					10	0.89880	0.0002	33.6338
					11	0.78841	0.0009	13.1409
					12	0.89535	0.0064	32.3321
					13	0.93374	0.0008	54.4363
					17	0.17698	0.C0C7	0.2587
OLIVIN	17				C18	0.92742	0.0013	49.1888
OTHER	18							

215

STEP NUMBER	4	VARIABLE REMOVED	15
MULTIPLE R	0.9997		
STC. ERROR OF EST.	0.0232		
ANALYSIS OF VARIANCE			
REGRESSION	2	SUM OF SQUARES 10.356	MEAN SQUARE 5.178
RESIDUAL	10	C.0005	F RATIO 9601.306

VARIABLES IN EQUATION				VARIABLES NOT IN EQUATION			
VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CCRR.	TOLERANCE	F TO ENTER
(CONSTANT)	C.000003	0.00003	89.8462	1	0.33894	0.0033	1.1681
QUARTZ	0.000028	C.00005	326.6563	2	0.22156	0.0044	0.4915
PLAGIO	0.00084			3	0.85690	0.0009	24.8706
				4	0.23829	0.0009	0.5418
				5	0.93339	0.0004	60.8859
				7	0.65775	0.0005	6.8626
				8	0.87625	0.0002	29.7611
				9	0.29506	0.0006	0.8583
				10	0.65629	0.0003	6.0095
				11	0.71083	0.0009	9.1923
				12	0.86014	0.0004	25.5142
				13	0.51093	0.0010	3.3329
				ORTHOC	1.5	0.46096	0.0062
				OLIVIN	1.7	-0.07461	0.0008
				COTHER	1.8	0.40883	0.0019
							1.8061

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.035C7
2	-0.01217
3	-0.02361
4	-0.02387
5	0.00225
6	0.01660
7	0.01649
8	0.02472
9	0.01100
10	0.00116
11	-0.022C3
12	-0.02516

QTZ MONZONITE
USGS 078

C16

SUB-PROBLEM 7
DEPENDENT VARIABLE 1C
MAXIMUM NUMBER OF STEPS 7
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.9981
STD. ERROR OF EST. 0.0577

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	5.742	9.742	2922.919
RESIDUAL	11	0.037	0.003	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	VARIABLES NOT IN EQUATION	F TO ENTER
(CONSTANT)	0.	)	0.00002	2922.9191	*	*	*	*
ORTHO ₁₅	0.00087				4	0.71196	0.0012	10.2793
					2	0.44313	0.0015	2.4434
					3	0.93617	0.0059	70.921C
					5	0.89694	0.0038	41.1499
					6	0.98222	0.0053	273.671B
					8	0.97418	0.0052	166.1808
					9	0.94890	0.0070	90.4195
					10	0.96852	C.01C6	151.3363
					11	0.96511	0.0082	135.8695
					12	0.91986	0.0081	54.9940
					13	0.92498	0.0076	59.2452
					QUARTZ	0.95004	0.0105	92.6532
					PLAGIC	0.41527	0.0205	2.0838
					16	0.78717	0.0124	16.2908
					CLIVIN	0.69932	0.0242	9.5713
					17	0.94563	C.0120	84.5321
					C.OTHER	18		

STEP NUMBER 2
VARIABLE ENTERED 16

MULTIPLE R 0.9993
STD. ERROR OF EST. 0.0373

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	9.764	4.882	3501.140
RESIDUAL	10	0.014	C.001	

C17

VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CCRR.	TOLERANCE	F TO ENTER
{CONSTANT	c. 0.00050	1	c. 0.0009	28.0983	1	c. 64722	6.4876
ORTHO15	0.00054	0.00013	16.2908	2	0.54567	0.0015	3.8161
PLAGIO16				3	0.33635	0.0014	20.9481
				4	0.89608	0.0016	36.6754
				5	0.95634	0.0012	96.3732
				6	0.33458	0.0021	62.1126
				8	0.96457	0.0009	120.2867
				9	0.55956	0.0021	104.799
				10	0.05929	0.0015	103.8216
				11	0.77604	0.0018	13.6231
				12	0.44904	0.0010	23.2433
				13	0.87435	0.0025	29.214C
				QUARTZ	14	0.96281	0.0195
				OLIVIN	17	-0.1652	0.0011
				CTHER	18	0.9258C	0.0069
						53.9807	
STEP NUMBER	3						
VARIABLE ENTERED		14					
MULTIPLE R		0.9999					
STC. ERR CR OF EST.		0.0106					
ANALYSIS OF VARIANCE							
REGRESSION	OF	SUM OF SQUARES		MEAN SQUARE	F RATIO		
RESIDUAL	3	5.777		3.259	28814.704		
	9	C.001		0.000			
VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CCRR.	TOLERANCE	F TO ENTER
{CONSTANT	c. 0.00020	1	0.00002	114.2882	1	0.06011	0.0006
QUARTZ14	0.00021	0.0004	31.1403	2	-0.11292	0.0009	0.0290
ORTHO15	0.00021	0.0004	259.2390	3	0.41648	0.0009	0.1033
PLAGIO16	0.00062	C.0004		4	0.16151	0.0004	1.6789
				5	0.64214	0.0003	0.2143
				6	0.59908	0.0004	5.6135
				8	0.77532	0.0002	4.4785
				9	0.69804	0.0003	12.0562
				10	0.71562	0.0002	7.6C26
LIST OF RESIDUALS				11	0.41200	0.0009	8.3974
CASE	RESIDUAL	6	0.01464	12	C.00203	C.0004	1.6356
1	0.00549	7	0.00696	13	0.49387	C.0008	2.6957
2	0.01087	8	0.00182	17	0.5C297	C.007	2.58C7
3	-0.01729	10	-0.00455	18	0.48077	0.0013	2.7092
4	-0.00357	11	-0.01062				2.4050
5	C.00627	12	-0.0002				

C18

PA HOE HOE BASALT
USGS 071

SUB-PROBLM 8
DEPENDENT VARIABLE 8
MAXIMUM NUMBER OF STEPS 16
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 16

MULTIPLE R 0.9990
STC. ERROR OF EST. 0.0448

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	10.867	10.867	5413.054
RESIDUAL	11	0.022	0.002	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	COEFFICIENT	STD. ERROR	F TO ENTER
(CONSTANT)	0.	0.00002	5413.0542	1	0.81079	0.0101	19.1866
PLAGIO 16	0.00130	0.00002		2	0.78220	0.0127	15.7626
				3	0.95879	0.0050	113.8717
				4	0.91199	0.0086	53.5776
				5	0.98977	0.0053	481.0518
				6	0.98827	0.0052	418.9047
				7	0.96794	0.0054	148.5192
				9	0.89376	0.0025	39.4816
				10	0.97155	0.0024	168.2524
				11	0.91229	0.0028	49.6218
				12	0.97065	0.0020	162.9114
				13	0.88591	0.0030	36.1349
				QUARTZ 14	0.95764	0.0392	110.5811
				CRTHCC 15	0.74017	0.0124	12.1169
				CLIVIN 17	-0.76987	0.0028	14.5517
				CTHER 18	0.90449	0.0085	44.9771

STEP NUMBER 2
VARIABLE ENTERED 14

MULTIPLE R 0.9999
STC. ERROR OF EST. 0.0135

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	10.887	5.444	29724.026
RESIDUAL	10	C.002	0.000	

C19

VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION			TOLERANCE	F TO ENTER
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CORR.	CORRELATION			
(CONSTANT)	c. 0.00018	0.00002	110.5811	1	0.16639	0.0033	0.2563		
QUARTZ 14	0.00103	0.00003	1437.0743	2	0.05167	0.0044	0.0241		
PLAGIO 16				3	0.76392	c.009	12.6125		
				4	0.12868	0.009	0.1515		
				5	0.87144	0.004	0.4072		
				6	0.87623	0.005	29.7574		
				7	0.61935	0.005	5.6007		
				9	0.46646	0.006	1.7812		
				10	0.7C975	0.003	9.1357		
				11	0.7C851	0.009	9.0719		
				12	0.88399	0.004	32.1797		
				13	0.60398	0.0010	5.1687		
CRTHOC	15	0.3C641	0.0062			0.9325			
CLIVIN	17	0.19232	0.0008			0.3457			
COTHER	18	0.44091	0.0019			2.1718			

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.01437
2	0.00225
3	-0.01131
4	-0.01683
5	0.00340
6	0.01991
7	0.01370
8	0.00386
9	0.00629
10	-0.00572
11	-0.01134
12	-0.01563

PAHOEHOE (SAWED)
USGS 072

SUB-PROBLEM 9
 DEPENDENT VARIABLE 9
 MAXIMUM NUMBER OF STEPS 1C
 F-LEVEL FOR INCLUSION 6.000000
 4.000000
 F-LEVEL FOR DELETION 0.000100
 TOLERANCE LEVEL

STEP NUMBER 1 16
 VARIABLE ENTERED 0.9998
 MULTIPLE R 0.0430
 STD. ERROR OF EST.
 ANALYSIS OF VARIANCE DF SUM OF SQUARES MEAN SQUARE F RATIO
 REGRESSION 1 1C.620 10.62C 4423.231
 RESIDUAL 11 0.026 0.02C

VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.	)	0.00002	4423.2313	1 0.52379	0.0101	3.78C8
PLAGIO	16 0.00129			2 0.49336	0.0127	3.2170	
				3 0.84316	C-C05C	24.5916	
				4 0.74475	C-C066	12.4446	
				5 0.8834C	0.0053	35.5354	
				6 0.87783	0.0052	32.2966	
				7 0.78597	0.0054	16.1663	
				8 0.89326	0.0020	39.4816	
				9 0.95979	0.0024	116.8990	
				10 0.91654	0.0028	27.6434	
				11 0.89495	0.0020	40.2337	
				12 0.96026	C-C030	118.3727	
				13 QUARTZ 14	0.0392	32.1013	
				14 CORTHOC 15	0.87320		
				15 CLIVIN 17	0.38148	1.7666	
				16 -0.58649	0.0124	5.2431	
				17 C'HER 18	0.0028	0.0085	
					0.96651	141.8418	

STEP NUMBER 2 14
 VARIABLE ENTERED 0.9997
 MULTIPLE R 0.025C
 STD. ERROR OF EST.
 ANALYSIS OF VARIANCE DF SUM OF SQUARES MEAN SQUARE F RATIO
 REGRESSION 2 1C.641 5.32C 848C.765
 RESIDUAL 10 0.006 0.001

C20

(P21)

VARIABLES IN EQUATION				VARIABLES NOT IN EQUATION			
VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CCRR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.						
QUARTZ	0.00018	C.000C3	32.1C13	1	-C.67884	C.CC13	7.6921
14	0.00101	C.00005	4.08.C695	2	-0.13726	C.GU44	10.7175
PLAGIO	0.			3	0.2638U	C.C009	0.5732
16				4	-0.51523	C.GG69	3.2227
				5	0.12612	C.C0064	1.C711
				6	0.29506	C.0665	0.8582
				7	-0.34456	0.0005	1.2124
				8	0.4C646	C.C002	1.812
				10	0.84308	C.GG03	22.1182
				11	0.47545	0.0009	2.687
				12	0.52174	0.0004	3.3662
				13	0.87531	C.CJ1C	29.4882
				15	-0.66983	C.CC62	7.242
				17	0.53513	0.0068	3.6115
				18	0.8549U	0.0019	24.4401

VARIABLES IN EQUATION				VARIABLES NOT IN EQUATION			
VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CCRR.	TOLERANCE	F TO ENTER
(CONSTANT)	C.						
QUARTZ	0.00025	0.00004	49.4086	1	-C.22198	0.0066	0.4146
14	0.			2	-0.41749	0.0009	1.6887
ORTHO	-0.00019	0.00007	7.3242	3	0.64420	0.0009	5.9856
15	0.			4	-0.0708C	0.0004	0.0403
PLAGIO	0.000117	0.00007	271.0229	5	0.94807	0.0003	71.0767
16				6	0.1638	0.0004	41.0253

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL	RESIDUAL	RESIDUAL	RESIDUAL	RESIDUAL	RESIDUAL	RESIDUAL
1	0.02156				1.1	0.66284	0.0009
2	-0.0C133				1.2	0.66471	0.0004
3	-0.00871	9	-0.C1548		1.3	0.86452	C.C008
4	-0.00912	10	-0.CC951		17	0.34128	C.CC07
5	0.CC82C	11	-0.C2195		18	-0.01968	0.0007
6	C.C248	12	-0.01968				
7	0.01637						
8	0.C1932						

AA BARAL
0895089

C22

SUB-PROBLM 10
DEPENDENT VARIABLE IC
MAXIMUM NUMBER OF STEPS 1C
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 16

MULTIPLE R 0.9988
STD. ERROR OF EST. 0.0514

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	12.061	12.061	4.563.395
RESIDUAL	11	0.029	0.003	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT)	0.	0.00002	4563.3946
PLAGIC 16	0.00137		

VARIABLE	PARTIAL CORR.	TOLERANCE	F TU ENTER
1	0.70225	0.0101	9.7300
2	0.67016	0.0127	8.1527
3	0.94071	0.0050	76.9092
4	0.85311	0.0086	26.7372
5	0.98963	0.0053	157.1689
6	0.96110	0.0052	131.8286
7	0.91329	0.0054	50.2779
8	0.97155	0.0020	168.2524
9	0.95919	0.0025	116.8990
10	0.92800	0.0028	62.0426
11	0.96248	0.0020	125.8242
12	0.94109	0.0030	80.4338
13	0.94426	0.0392	82.2781
QUARTZ 14			
CRTHCC 15			
CLIVIN 17			
OTHER 18			

STEP NUMBER 2
VARIABLE ENTERED 14

MULTIPLE R 0.9999
STD. ERROR OF EST. 0.0178

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	12.087	6.044	19182.116
RESIDUAL	1C	C.003	0.000	

C23

VARIABLE	VARIABLES IN EQUATION			VARIABLE TO REMOVE	VARIABLE	VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO ENTER			PARTIAL CGRR.	TOLERANCE	F TO ENTER
(CONSTANT)						-0.36966	C.0033	1.4247
QUARTZ	C.00020	C.C0CC2	82.2781	1	-0.47634	0.0044	2.6414	
14	0.00106	0.0004	890.2458	2	0.62598	0.0069	5.7989	
PLAGIO	16			3	-6.37717	0.0099	1.4926	
				4	0.68150	C.0004	7.8051	
				5	0.65629	0.0055	6.8093	
				6	0.10680	0.0055	3.1038	
				7	0.70975	0.0002	9.1357	
				8	0.84308	0.0006	22.1182	
				9	0.76850	0.0009	-2.9830	
				11	0.74921	0.0004	15.9126	
				12	C.89510	0.0010	36.2718	
				13	-0.25114	0.0012	0.6058	
				15	CIVIN	0.0008	0.5966	
				17	O.24934	0.0008		
				18	C.HER	0.0019	18.9291	

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.01229
2	0.00879
3	-0.00819
4	0.00432
5	0.01376
6	0.01981
7	0.01350
8	0.01419
9	-0.01386
10	-0.00683
11	-0.02358
12	-0.02953

AA BAYALT ROUGH

C24

USGS 086

SUB-PROBLEM 11
 DEPENDENT VARIABLE 11
 MAXIMUM NUMBER OF STEPS 10
 F-LEVEL FOR INCLUSION 6.000000
 F-LEVEL FOR DELETION 4.000000
 TOLERANCE LEVEL 0.000100

STEP NUMBER 1
 VARIABLE ENTERED 16

MULTIPLE R 0.9986
 STC. ERROR OF EST. 0.0549

ANALYSIS OF VARIANCE
 REGRESSION DF 1
 RESIDUAL 11

SUM OF SQUARES
 11.682
 C.003

MEAN SQUARE
 11.682
 0.003

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.00135	1	0.00002	3872.2166	1	0.60453	0.0101
PLAGIO 16	0.00135	1	0.00002	3872.2166	2	0.5803	0.0127
					3	0.9723	0.0050
					4	0.70797	10.492
					5	0.91172	49.2514
					6	0.9164	52.3016
					7	0.83392	22.8329
					8	0.91229	49.6218
					9	0.85624	0.0025
					10	0.92800	0.0024
					11	0.96500	0.0020
					12	0.93733	135.3977
					13	0.93561	0.0030
					14	0.83592	72.3619
					15	0.60106	23.1391
					CLIVIN 17	-0.78450	5.6563
					COTHER 18	0.93151	0.0085

STEP NUMBER 2
 VARIABLE ENTERED 14

MULTIPLE R 0.9996
 STC. ERROR OF EST. 0.0316

ANALYSIS OF VARIANCE
 REGRESSION DF 2
 RESIDUAL 10

SUM OF SQUARES
 11.705
 0.010

MEAN SQUARE
 5.853
 0.001

F RATIO
 5844.372

C25

VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION			
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CORR.	TOLERANCE	F TO ENTER	
CONSTANT	0.)	C.C0C04	23.1391	1	-0.24956	C.CC33	0.5978
QUARTZ 14	0.00019	C.C0006	277.6796	2	-0.36070	0.CC44	1.3460	
PLAGIC 16	C.C0105			3	0.92140	0.CC99	50.5955	
				4	-0.46395	0.C0019	2.4686	
				5	0.71088	0.C904	9.6256	
				6	0.71C84	0.CC55	1.928	
				7	0.21681	0.C005	0.4439	
				8	0.70851	0.C0C2	9.0719	
				9	0.47545	0.C006	2.6287	
				10	0.76850	0.C003	4.2.9830	
				11	0.88613	0.C004	32.9046	
				12	0.80172	0.CC10	16.1933	
				13	0.02473	0.C0062	0.0055	
				14	-0.28703	0.C006	0.8060	
				15	0.75134	0.C0019	11.6664	
				16				
				17				
				18				

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.01371
2	0.01084
3	-0.00647
4	-0.00007
5	0.00997
6	0.01637
7	0.01989
8	0.03013
9	0.03211
10	-0.01061
11	-0.04708
12	-0.06185

AA BAZANT
VS 95 91

SUB-PROBLEM 12
DEPENDENT VARIABLE 12
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 16
MULTIPLE R 0.9990
STD. ERROR OF EST. 0.00445

ANALYSIS OF VARIANCE
DF SUM OF SQUARES MEAN SQUARE F RATIO
REGRESSION 1 11.065 11.065 5586.727 0.002
RESIDUAL 11 0.022

VARIABLES IN EQUATION				VARIABLES NOT IN EQUATION			
VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.00132	0.00002	5586.7274	1	0.71744	0.0101	10.6068
PLAGIO	16	0.00132	0.00002	2	0.67528	0.0127	8.3825
				3	0.97634	0.0050	187.4220
				4	0.82011	0.0086	26.5417
				5	0.96598	0.0053	159.0866
				6	0.97043	0.0052	161.6439
				7	0.90559	0.0054	45.5846
				8	0.97065	0.0020	162.9114
				9	0.89495	0.0025	40.2337
				10	0.96248	0.0024	125.8242
				11	0.96500	0.0028	135.3977
				13	0.93418	0.0030	68.5447
				QUARTZ	14	0.89503	0.0392
				CRTHOC	15	0.68582	0.0124
				OLIVIN	17	-0.75774	8.8851
				CTHER	18	0.9238C	0.0028
							13.4837
							58.2178

STEP NUMBER 2
VARIABLE ENTERED 14
MULTIPLE R 0.9998
STD. ERROR OF EST. 0.0208

ANALYSIS OF VARIANCE
DF SUM OF SQUARES MEAN SQUARE F RATIO
REGRESSION 2 11.082 5.541 12785.778
RESIDUAL 10 0.004 C.000

C26

C27

VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION			TOLERANCE	F TO ENTER
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CORR.	CORRELATION	VARIABLE		
CONSTANT	C.000017	0.0003	40.2609	1	-0.05676	C.0033			
QUARTZ	0.000106	0.0004	645.5342	2	-0.18091	0.0044			
PLAGIC	0.000106	0.0004		3	0.86744	C.0009			
				4	-0.18441	0.0009			
				5	0.89448	C.0004			
				6	0.86014	0.0005			
				7	0.38088	0.0005			
				8	0.88399	C.0002			
				9	0.52174	C.0006			
				10	0.79921	C.0003			
				11	0.88613	0.0009			
				12	0.88613	0.0009			
				13	0.78402	C.0002			
				14	0.78402	0.0002			
				15	0.16629	C.0002			
				16	0.16629	0.0002			
				17	-0.03993	0.0008			
				18	C.63934	0.0019			
						6.22221			

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.01952
2	-0.00194
3	-0.00153
4	-0.01344
5	-0.00173
6	0.02569
7	0.01853
8	0.01750
9	0.00929
10	-0.00314
11	-0.02925
12	-0.03378

AA BASALT
USGS 090

SUB-PRCBLM 13
DEPENDENT VARIABLE
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000C
F-LEVEL FOR DELETION 4.000000C
TOLERANCE LEVEL 0.000100C

STEP NUMBER 1
VARIABLE ENTERED 16

MULTIPLE R 0.9985
STD. ERROR OF EST. 0.0544

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	10.968	10.968	3704.211
RESIDUAL	11	C.033	0.003	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
(CONSTANT)	C.00131	0.00002	3704.2107
PLAGIC	16		

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	
(CONSTANT)	C.00131	0.00002	3704.2107	
PLAGIC	16			
1	0.47316	0.01011	2.8847	
2	0.42755	0.01277	2.2369	
3	0.49546	0.00506	40.4658	
4	0.66502	0.00866	7.9294	
5	0.85992	0.00553	31.1123	
6	0.87422	0.00552	32.4197	
7	0.75278	0.00554	13.0778	
8	0.88501	0.00550	36.3349	
9	0.96026	0.00255	118.3127	
10	0.94309	0.00246	80.5358	
11	0.91733	0.00268	72.3619	
12	0.93418	0.00260	68.5447	
14	0.83028	0.00262	20.5671	
CRTHC	15	0.39806	0.01246	1.3829
CLIVIN	17	-0.61284	0.00286	6.0146
OTHER	18	0.97979	0.00855	239.9615

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.02308
2	0.00058
3	0.01533
4	0.01842
5	0.02808
6	0.03425
7	0.01832
8	0.00892
9	-0.00852
10	-0.02253
11	-0.04617
12	-0.06047

FINISH CARD ENCOUNTERED
PROGRAM TERMINATED

C29

VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.00019	0.00004	20.571	1	-0.66CC73	0.0033	5.1817
QUARTZ 14	0.00019	0.00004	24.4581	2	-0.69658	0.0044	8.4833
PLAGIC 16	0.000102	0.00007	3	0.62990	0.009	5.9224	
			4	-0.59907	0.009	5.0381	
			5	0.51739	0.004	3.2899	
			6	0.53093	0.005	3.5529	
			7	-C.18934	0.005	0.3347	
			8	0.60398	0.002	5.1687	
			9	0.87531	0.006	29.4882	
			10	0.89510	0.003	36.2718	
			11	0.8C172	0.009	16.1933	
			12	0.78402	0.004	14.3575	
			13	-0.45183	0.0062	2.3C87	
			14	0.23130	0.0008	0.5C87	
			15	0.95C94	0.0019	85.0260	
CLIVIN	17						
OTHER	18						

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

D1

PROBLEM CODE	SURVEY
NUMBER OF CASES	12
NUMBER OF ORIGINAL VARIABLES	18
NUMBER OF VARIABLES ADDED	-0
TOTAL NUMBER OF VARIABLES	18
NUMBER OF SUB-PROBLEMS	13

MODAL ANALYSIS

PROGRAM II

(STANFORD TRAINING
 SET USED
NORMALISED DATA

VARIABLE	MEAN	STANDARD DEVIATION	STANFORD SUB PROBLEM #	USES#
1	-0.03792	1.02210	0.74321	71
2	-0.03050	1.02999	1.38751	72
3	0.02392	1.04327	0.78425	75
4	-0.02417	1.03156	0.57186	79
5	-0.03242	1.00471		80
6	-0.03975	0.99223		
7	-0.04467	1.00361		
8	-0.07167	0.99735		
9	-0.06217	0.99429		
10	-0.03833	1.01430		
11	0.01367	1.10000		
12	-0.08400	0.98482		
13	-0.01783	1.03977		
QUARTZ 14	0.01183	1.54648		
ORTHOCL 15	0.37475	0.99429		
PLAGIO 16	-1.29958	1.01430		
OLIVIN 17	-0.32658	0.98482		
OTHER 18	-0.51933	1.03977		

ROCK TYPE	Mono Lake, California
Obsidian, grey	Obsidian, black
Rhyolite pumice, weathered	Rhyolite pumice, weathered
Bishop Tuff (upper)	Bishop Tuff (lower)
Quartz Monzonite, weathered	
Pisgah Crater, California	
Basalt, pahoehoe, weathered	Basalt, pahoehoe, sawed
Basalt, aa, weathered	Basalt, aa, weathered
Basalt, aa, weathered	Basalt, aa, weathered
Basalt, aa, rough	

OBSIDIAN Gray

D2

(D3 omitted)

SUB-PROBLEM 1
DEPENDENT VARIABLE 1
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.7267
STD. ERROR OF EST. 0.7334

ANALYSIS OF VARIANCE
REGRESSION DF 1 SUM OF SQUARES 6.620 MEAN SQUARE 6.620 F RATIO 12.307
RESIDUAL 11 5.917 0.538

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.99935	0.28486	12.3073	2	0.99263	0.4420	670.5853
ORTHO 15	0.99935	0.28486	12.3073	3	0.67760	0.5714	6.4892
				4	0.90612	0.6093	45.8829
				5	0.90119	0.5386	43.2323
				6	0.94719	0.5976	87.2498
				7	0.94477	0.4887	83.1012
				8	0.50127	0.5562	3.3561
				9	0.11159	0.9174	0.1261
				10	0.44596	0.5110	2.4825
				11	0.02264	0.6105	0.0051
				12	0.28708	0.6158	0.8982
				13	-0.23916	0.9448	0.6067
				QUARTZ 14	0.16404	0.6596	0.2765
				PLAGIO 15	0.60253	0.7244	5.4997
				OLIVIN 16	-0.08137	0.7333	0.0666
				OTHER 17	0.89499	0.7296	40.2539
				18			

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL		
1	-0.45902	12	0.33674
2	-1.37788		
3	-1.47403		
4	-0.93217		
5	-0.11543		
6	-0.15604		
7	-0.25581		
8	-0.2161		
9	-0.38335		
10	-0.1924		
11	0.11679		

OBSIDIAN Blanks

D4

SUB-PRGBLM 2
DEPENDENT VARIABLE 2
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.7197
STD. ERROR OF EST. 0.7469

ANALYSIS OF VARIANCE
REGRESSION DF SUM OF SQUARES MEAN SQUARE F RATIO
RESIDUAL 1 6.594 6.594 11.621
RESIDUAL 11 6.136 0.558

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
CONSTANT	0.						
ORTHOC	0.99743	0.29010	11.8213	1	0.99263	0.4720	670.5853
15				3	0.66051	0.574	7.7393
				4	0.94225	0.6093	79.1591
				5	0.91995	0.5436	55.0677
				6	0.95493	0.5976	103.4919
				7	0.55906	0.4887	114.4924
				8	0.7859	0.5562	2.9710
				9	0.13652	0.9674	0.1899
				10	0.4353	0.5810	2.4489
				11	-0.03256	0.6105	0.0106
				12	0.23214	0.6138	0.5696
				13	-0.26523	0.9948	0.7567
				14	0.21345	0.6296	0.4774
				QUARTZ	0.57373	0.7244	4.9068
				PLAGIO	0.11565	0.733	0.1356
				OLIVIN	-0.11565	0.7296	29.6278
				OTHER	0.86467		
				18			

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL	CASE	RESIDUAL
1	-0.6109	12	0.47391
2	-1.4553		
3	-1.3314		
4	-0.8868		
5	0.21231		
6	-0.21115		
7	-0.18725		
8	-0.23349		
9	-0.36445		
10	-0.17602		
11	0.14412		

RHYOLITE PUMICE

DS

SUB-PROBLEM 3
DEPENDENT VARIABLE 3
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.6546
STD. ERROR OF EST. 0.8237

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	5.597	5.597	8.250
RESIDUAL	11	7.464	0.679	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
CONSTANT	0.91895	0.31995	8.2496	1	0.67760	0.4720	0.4892
ORTHOC	15			2	0.66051	0.4820	7.7393
				4	0.49571	0.6093	3.2578
				5	0.67143	0.4986	8.2089
				6	0.76425	0.5976	14.0429
				7	0.61711	0.4887	6.1506
				8	-0.01892	0.5562	0.0036
				9	-0.58468	0.9674	5.1941
				10	-0.21382	0.5910	0.4791
				11	0.34926	0.6195	1.3893
				12	-0.02124	2.6158	0.0045
				13	-0.55167	0.9948	4.3749
				14	0.31373	0.6296	1.0917
				15	0.32458	0.7244	1.1775
				16	-0.41619	0.7333	2.0950
				17	0.70803	0.7296	10.0521
				OTHER	18		

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL	---	---	---	---
1	-0.55584	12	---	---	-0.48101
2	-1.50225				
3	-1.28830				
4	-0.71140				
5	2.02651				
6	-0.14318				
7	-0.38725				
8	0.39992				
9	1.16948				
10	-0.12398				
11	-0.55432				

RHYOLITE PUMICE

075

D6

SUB-PROBLEM 4
 DEPENDENT VARIABLE 4
 MAXIMUM NUMBER OF STEPS 10
 F-LEVEL FOR INCLUSION 6.000000
 F-LEVEL FOR DELETION 4.000000
 TOLERANCE LEVEL 0.000100

STEP NUMBER 1
 VARIABLE ENTERED 15

MULTIPLE R 0.6250
 STD. ERROR OF EST. 0.0410

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	4.989	4.989	7.052
RESIDUAL	11	7.781	0.707	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
CONSTANT	0.						
ORTHOC 15	0.86753	0.32667	7.0525	1	0.90612	0.4720	45.8629
				2	0.94225	0.4820	79.1591
				3	0.49571	0.5714	3.2578
				5	0.90516	0.5486	45.3427
				6	0.89344	0.5976	39.5605
				7	0.91706	0.4887	52.8904
				8	0.36682	0.5562	1.5548
				9	0.22421	0.9674	0.5293
				10	0.38835	0.5810	1.7760
				11	-0.32915	0.6105	1.2150
				12	0.03254	0.6159	0.0106
				13	-0.30521	0.9948	1.0272
				QUARTZ 14	0.36846	0.6296	1.5709
				PLAGIO 16	0.41332	0.7244	2.0603
				OLIVIN 17	-0.21831	0.7333	0.5005
				OTHER 18	0.69987	0.7226	9.6010

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	-0.9764
2	-1.6989
3	-1.1432
4	-0.6697
5	0.2657
6	0.10018
7	-0.0219
8	-0.4684
9	-0.6346
10	-0.2534
11	0.4095

12 - 0.63135

BISHOP TUFF Upper

D7

SUB-PROGRAM 5
 DEPENDENT VARIABLE 5
 MAXIMUM NUMBER OF STEPS 10
 F-LEVEL FOR INCLUSION 6.000000
 F-LEVEL FOR DELETION 4.000000
 TOLERANCE LEVEL 0.000100

STEP NUMBER 1
 VARIABLE ENTERED 15

MULTIPLE R 0.6719

STD. ERROR OF EST. 0.7773

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	5.468	5.468	9.050
RESIDUAL	11	6.646	0.604	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.90824	0.30190	9.0505	1	0.90119	0.4720	43.2323
ORTHO15	0.90824	0.30190	9.0505	2	0.91995	0.4820	55.0677
				3	0.67143	0.5714	6.2089
				4	0.90516	0.6093	45.3427
				5	0.94719	0.5976	87.2442
				6	0.92275	0.4987	57.3255
				7	0.24397	0.5562	0.6329
				8	-0.00888	0.9674	0.0008
				9	0.24019	0.3810	0.6122
				10	-0.12406	0.6105	0.1563
				11	0.05865	0.6158	0.0345
				12	-0.42606	0.9448	2.2179
				13	-0.38655	0.6296	1.7567
				QUARTZ	0.44687	0.7244	2.4951
				PLACIO	0.7244	0.7333	0.9969
				OLIVIN	-0.30109	0.79317	0.7296
				OTHER	0.79317	16.9623	

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL	12	0.37314
1	-1.07121		
2	-1.58230		
3	-1.05486		
4	-0.86322		
5	-0.19C56		
6	0.2C359		
7	0.19788		
8	0.24114		
9	-0.43789		
1C	-0.27656		
11	-0.01252		

BISHOP TUFF Lower

SUB-PROBLEM 6
 DEPENDENT VARIABLE 1
 MAXIMUM NUMBER OF STEPS 10
 F-LEVEL FOR INCLUSION 6.000000
 F-LEVEL FOR DELETION 4.000000
 TOLERANCE LEVEL 0.000100

080
 088

STEP NUMBER 1
 VARIABLE ENTERED 15

MULTIPLE R 0.6343
 STD. ERROR OF EST. 0.8012

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	4.754	4.754	7.406
RESIDUAL	11	7.060	0.642	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
CONSTANT	0.84687	0.31118	7.4064	1	0.94719	0.4720	87.2498
ORTHO15	0.0	0.4064		2	0.95493	0.4820	103.4919
				3	0.76425	0.5714	14.0429
				4	0.89344	0.6093	39.5605
				5	0.94719	0.5486	87.2442
				7	0.90916	0.4887	47.6606
				8	0.5562	0.5562	0.8347
				9	-0.01919	0.9674	0.0531
				10	0.22135	0.5810	0.5152
				11	-0.04600	0.6105	0.0412
				12	0.10236	0.6158	0.0559
				13	-0.36849	0.9948	1.5712
				QUARTZ	0.39113	0.6296	1.8061
				PLAGIO	0.40859	0.7244	2.0040
				OLIVIN	-0.32769	0.7333	1.2030
				OTHER	0.80233	0.7296	18.0688

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL	12	0.30980
1	-0.62536		
2	-1.77213		
3	-1.22212		
4	-1.67343		
5	0.22494		
6	0.33697		
7	0.05987		
8	-0.12934		
9	-0.21195		
10	-0.32327		
11	-0.67895		

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SUB-PROGRAM 7
 DEPENDENT VARIABLE 7
 MAXIMUM NUMBER OF STEPS 10
 C-LEVEL FOR INCLUSION 6.000000
 F-LEVEL FOR DELETION 4.000000
 F-LEVEL FOR DELETION 4.000000
 TOLERANCE LEVEL 0.000100

STEP NUMBER 1
 VARIABLE ENTERED 15

MULTIPLE R 0.7150
 STD. ERROR OF EST. 0.07328

ANALYSIS OF VARIANCE
 REGRESSION 1 DF SUM OF SQUARES 6.180
 RESIDUAL 11 5.907

VARIABLES IN EQUATION
 VARIABLE COEFFICIENT STD. ERROR F TO REMOVE
 (CONSTANT) 0.96557 1 0.28463 11.5079

VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.96557	1	0.28463	11.5079	1 0.94477	0.4720	83.1012
ORTHOC 15	0.96557	1	0.28463	11.5079	2 0.95006	0.4820	114.6924
					3 0.61711	0.5714	6.1506
					4 0.91706	0.6093	52.8904
					5 0.92275	0.5486	57.3255
					6 0.90916	0.5976	47.6906
					8 0.48626	0.5562	3.0968
					9 0.11976	0.9674	0.1555
					10 0.45731	0.5810	2.6443
					11 -0.00151	0.6105	0.0000
					12 0.21186	0.6158	0.4659
					13 -0.33906	0.9948	1.2989
					QUARTZ 14 0.21337	0.6296	0.4770
					PLAGIO 16 0.58073	0.7244	5.0887
					OLIVIN 17 -0.13684	0.7333	0.1908
					OTHER 18 0.85274	0.7296	26.6512

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION
 LIST OF RESIDUALS

CASE	RESIDUAL	12	0.45607
1	-1.04920		
2	-1.01873		
3	-1.2082		
4	-1.06709		
5	0.43328		
6	-0.06803		
7	-0.16791		
8	-0.21469		
9	-0.36481		
10	-0.28607		
11	-0.13983		

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SUB-PROBLM 8
DEPENDENT VARIABLE 8
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.66662
STD. ERROR OF EST. 0.77669

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	5.297	5.297	8.776
RESIDUAL	11	6.639	0.604	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.						
ORTHOC 15	0.89396	0.30176	8.7761	1	0.50127	0.4720	3.3561
				2	0.47859	0.4820	2.9710
				3	-0.01892	0.5714	0.0036
				4	0.36682	0.6093	1.5448
				5	0.23397	0.5486	0.3329
				6	0.27756	0.5976	0.8347
				7	0.48626	0.4887	3.0968
				9	0.61412	0.9674	0.3299
				10	0.88267	0.5810	35.2718
				11	0.55481	0.6105	1.4402
				12	0.37675	0.6159	33.2323
				13	0.55755	0.9948	4.5108
				QUARTZ 14	-0.44130	0.6226	6.3856
				PLACIO 16	0.77096	0.7244	14.6540
				OLIVIN 17	0.74390	0.7333	12.3904
				OTHER 18	0.54678	0.7296	4.2647

STEP NUMBER 2
VARIABLE ENTERED 16

MULTIPLE R 0.8800
STD. ERROR OF EST. 0.5189

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	9.244	4.622	17.162
RESIDUAL	10	2.693	0.269	

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VARIABLE	VARIABLES IN EQUATION			VARIABLE	VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO REMOVE		PARTIAL CORR.	TOLERANCE	F TO ENTER
CONSTANT	0.36985	0.23682	33.4586	1	0.07229	0.3006	0.0473
ORTHO _C 15	1.48550	0.12685	14.6540	2	0.06933	0.3233	0.0437
PLAGIO 16	0.48550	0.12685	14.6540	3	-0.44680	0.5112	2.2448
				4	0.08306	0.5052	0.0625
				5	-0.17648	0.4391	0.2893
				6	-0.06442	0.4979	0.0375
				7	0.07433	0.3239	0.0500
				8	0.67576	0.8476	7.5638
				9	0.75895	0.3022	12.2268
				10	-0.07612	0.4491	0.0524
				11	0.71496	0.2787	9.4112
				12	0.57094	0.9229	4.3527
				13	-0.32153	0.3842	1.0377
				14	0.54389	0.6620	3.7897
				OLIVIN 17	-0.25864	0.2205	0.6452
				OTHER 18			

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.72729
2	0.42118
3	0.01926
4	-0.67344
5	0.39098
6	0.00083
7	-0.07303
8	-0.50009
9	-0.40753
10	-0.32019
11	0.26665
12	0.69971

SUB-PRCBM 9
DEPENDENT VARIABLE 9
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

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D/2

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LIST OF RESIDUALS

CASE	RESIDUAL
1	0.39700
2	-0.39700
3	0.39700
4	-0.15000
5	-0.70500
6	-0.70500
7	-0.70500
8	-0.70500
9	-1.83100
10	-0.15000
11	0.94800
12	2.05000

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SUB-PROBLEM 13
DEPENDENT VARIABLE 10
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.6473
STD. ERROR OF EST. 0.8075

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	5.172	5.172	7.931
RESIDUAL	11	7.173	0.652	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.88336	0.31366	7.9313	1	0.44596	0.4720	2.4825
ORTHO C 15	0.4473	0.44353	0.44353	2	0.44353	0.4820	2.4489
		0.21382	0.21382	3	-0.21382	0.5714	0.4791
		0.38835	0.38835	4	0.38835	0.6093	1.7760
		0.24019	0.24019	5	0.24019	0.5486	0.6122
		0.22135	0.22135	6	0.22135	0.5976	0.5152
		0.45731	0.45731	7	0.45731	0.4887	2.6443
		0.88267	0.88267	8	0.88267	0.5562	35.2718
		0.83884	0.83884	9	0.83884	0.9674	23.7439
		0.13959	0.13959	11	0.13959	0.6105	0.1987
		0.71319	0.71319	12	0.71319	0.6158	10.3518
		0.49636	0.49636	13	0.49636	0.9948	3.2691
		-0.55556	-0.55556	14	-0.55556	0.6296	4.4643
		0.69275	0.69275	15	0.69275	0.7244	9.2271
		0.69681	0.69681	16	0.69681	0.7333	9.4382
		0.44634	0.44634	17	0.44634	0.7296	2.4879
				OTHER 18			

STEP NUMBER 2
VARIABLE ENTERED 17

MULTIPLE R 0.8373
STD. ERROR OF EST. 0.6075

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	8.655	4.328	11.727
RESIDUAL	10	3.690	0.369	

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VARIABLES IN EQUATION				VARIABLES NOT IN EQUATION			
VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
CONSTANT	0.32051	0.27554	22.9671	1	0.70314	0.4688	8.8007
ORTHOC	15	0.80222	0.26113	2	0.73566	0.4756	10.6164
OLIVIN	17	0.80222	0.4382	3	0.11681	0.4225	0.1245
				4	0.77216	0.503	13.2899
				5	0.65792	0.4989	6.8689
				6	0.66360	0.5334	7.0819
				7	0.77784	0.496	13.7869
				8	0.76004	0.284	12.3101
				9	0.68809	0.520	8.0931
				11	-0.25634	0.4936	0.6330
				12	0.33283	0.165	1.1212
				13	-0.15766	0.354	0.2294
				QUARTZ	0.45035	0.054	2.4897
				PLAGIO	0.47233	0.464	2.5844
				OTHER	0.51622	0.7203	3.2696

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	-0.57689
2	-0.2371
3	-0.8691
4	-0.5277
5	0.4660
6	-0.20229
7	-0.2119
8	-0.0688
9	-1.0612
10	0.13406
11	0.20549
12	0.64382

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SUB-PROBLEM 11
DEPENDENT VARIABLE 11
MAXIMUM NUMBER OF STEPS 10
F-LEVEL FOR INCLUSION 6.000000
F-LEVEL FOR DELETION 4.000000
TOLERANCE LEVEL 0.000100

STEP NUMBER 1
VARIABLE ENTERED 15

MULTIPLE R 0.6241
STD. ERROR OF EST. 0.8977

ANALYSIS OF VARIANCE
REGRESSION DF SUM OF SQUARES MEAN SQUARE F RATIO
1 5.656 5.656 7.019
RESIDUAL 11 8.864 0.806

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT)	0.92375	0.34867	7.0190	1	0.02264	0.4720	0.0051
ORTHO 15				2	-0.03256	0.420	0.0106
				3	0.34926	0.514	1.3893
				4	-0.32915	0.693	1.2150
				5	-0.12406	0.586	0.1563
				6	-0.04600	0.5976	0.0212
				7	-0.00151	0.4887	0.0000
				8	0.35481	0.562	1.4402
				9	-0.22348	0.9674	0.5257
				10	0.13959	0.5810	0.1987
				12	0.61079	0.6158	5.9507
				13	0.20750	0.9948	0.4499
				QUARTZ 14	-0.62445	0.6796	6.3917
				PLAGIO 16	0.51415	0.7244	3.5934
				OLIVIN 17	0.43758	0.7333	2.3682
				OTHER 18	0.35165	0.7296	1.4111

STEP NUMBER 2
VARIABLE ENTERED 14

MULTIPLE R 0.7922
STD. ERROR OF EST. 0.7354

ANALYSIS OF VARIANCE
REGRESSION DF SUM OF SQUARES MEAN SQUARE F RATIO
2 9.112 4.556 8.426
RESIDUAL 10 5.408 0.541

D/S

D/6

VARIABLE	VARIABLES IN EQUATION			F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	VARIABLES NOT IN EQUATION
	COEFFICIENT	STD. ERROR	F TO ENTER					
"CONSTANT	0.							
QUARTZ 14	-0.43737	0.17300	6.3917	1	0.16233	0.4593	0.2436	
ORTHO 15	1.47763	0.35997	16.8497	2	0.1301	0.4600	0.1596	
				3	0.73510	0.5152	10.5806	
				4	-0.13643	0.5266	0.1707	
				5	0.16287	0.4666	0.2452	
				6	0.27577	0.5062	0.7408	
				7	0.17263	0.4665	0.2764	
				8	-0.07617	0.3275	0.0525	
				9	-0.73597	0.7630	10.6355	
				10	-0.31924	0.4017	1.0213	
				12	0.22026	0.2106	0.4947	
				13	-0.52004	0.4245	3.3362	
				PLAGIO 16	0.20310	0.4421	0.3896	
				OLIVIN 17	-0.61011	0.0761	5.3365	
				OTHER 18	0.34481	0.7161	1.2144	

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	-0.12034
2	0.25741
3	-0.1301
4	-0.1684
5	0.08574
6	-0.63174
7	0.12091
8	0.78589
9	1.23050
10	-0.19982
11	-0.82804
12	-0.66391

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D/7

SUB-PROBLEM 12
 DEPENDENT VARIABLE 12
 MAXIMUM NUMBER OF STEPS 10
 F-LEVEL FOR INCLUSION 6.000000
 F-LEVEL FOR DELETION 4.000000
 TOLERANCE LEVEL 0.000100

STEP NUMBER 1
 VARIABLE ENTERED 15

MULTIPLE R 0.6198
 STD. ERROR OF EST. 0.8072

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	4.471	4.471	
RESIDUAL	11	7.167	0.652	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	VARIABLES NOT IN EQUATION	F TO ENTER
(CONSTANT)	0.							
ORTHOIC	0.82131	0.31353	6.8620	1	0.28708	0.4720	0.8982	
				2	0.23214	0.4420	0.5696	
				3	-0.02124	0.5714	0.0045	
				4	0.03254	0.6693	0.0106	
				5	0.05865	0.486	0.0345	
				6	0.10236	0.5976	0.1059	
				7	0.21186	0.4887	0.4699	
				8	0.87675	0.5562	33.2323	
				9	0.50274	0.974	3.3824	
				10	0.71319	0.3518		
				11	0.61079	0.6105	5.9507	
				13	0.70842	0.9448	10.0746	
				14	-0.81117	0.6296	19.2391	
				PLAGIO	0.73989	0.7264	12.0964	
				OLIVIN	0.63499	0.733	23.0263	
				OTHER	0.45681	0.7296	2.6371	

STEP NUMBER 2
 VARIABLE ENTERED 17

MULTIPLE R 0.9020
 STD. ERROR OF EST. 0.4659

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	9.468	4.734	21.814
RESIDUAL	10	2.179	0.217	

D18

VARIABLE	VARIABLES IN EQUATION			F TO REMOVE	VARIABLE	VARIABLES NOT IN EQUATION		
	COEFFICIENT	STD. ERROR	F TO ENTER			PARTIAL CORR.	TOLERANCE	F TO ENTER
{CONSTANT	0.				1	0.64733	0.4688	6.4915
ORTHOC	15	1.34493	0.21130	40.5129	2	0.60140	0.4756	5.0997
OLIVIN	17	0.96089	0.20025	23.0263	3	0.65211	0.4725	6.6588
					4	0.40006	0.5803	1.7149
					5	0.59088	0.4989	4.9279
					6	0.72319	0.5334	9.8681
					7	0.53828	0.4796	5.0174
					8	0.69507	0.2484	8.4123
					9	-0.19281	0.5020	0.3475
					10	0.33283	0.2989	1.1212
					11	0.49601	0.4936	2.9368
					13	0.10421	0.3454	0.0988
					QJARTZ	14	-0.11683	0.0654
					PLAGIO	16	0.53116	0.4564
					OTHER	18	0.66357	3.5371
							0.7203	7.0808

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.15255
2	-0.41709
3	-0.44188
4	-1.22733
5	-0.07016
6	0.02111
7	0.02151
8	0.08938
9	0.01519
10	0.08567
11	-0.30924
12	-0.09105

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SUB-PROBLEM 13
 DEPENDENT VARIABLE 13
 MAXIMUM NUMBER OF STEPS 10
 F-LEVEL FOR INCLUSION 6.000003
 F-LEVEL FOR DELETION 4.000000
 TOLERANCE LEVEL 0.000100

STEP NUMBER 1
 VARIABLE ENTERED 17

MULTIPLE R 0.6530
 STD. ERROR OF EST. 0.8225

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	1	5.532	5.532	8.177
RESIDUAL	11	7.442	0.677	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
CONSTANT	0.						
OLIVIN 17	0.86577	0.30275	8.1775	1	0.23989	0.8210	0.6106
				2	0.22888	0.8060	0.5528
				3	0.04612	0.6310	0.0213
				4	0.16940	0.7803	0.2954
				5	0.13275	0.7106	0.1794
				6	0.18418	0.7035	0.3511
				7	0.16209	0.7964	0.2698
				8	0.50211	0.9828	3.3710
				9	0.46366	0.7590	2.7385
				10	0.45904	0.9855	2.6697
				11	0.29830	0.991	0.9767
				12	0.60081	0.9419	5.6487
				QUARTZ 14	0.31930	0.0831	1.1353
				ORTHOC 15	0.63070	0.7333	6.6051
				PLAGIO 16	-0.52072	0.4896	3.7202
				OTHER 18	-0.56520	0.8769	4.6941

STEP NUMBER 2
 VARIABLE ENTERED 15

MULTIPLE R 0.8091
 STD. ERROR OF EST. 0.6694

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	2	8.92	4.246	9.475
RESIDUAL	10	4.481	0.448	

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VARIABLE	VARIABLES IN EQUATION	COEFFICIENT	STD. ERROR	F TO REMOVE	VARIABLE	VARIABLES NOT IN EQUATION	PARTIAL CORR.	TOLERANCE	F TO ENTER
(CONSTANT	0.	0.78037	0.	6.6051	1	-0.29528	0.4686	0.8597	
ORTHOC	15	0.24768	0.28775	18.8002	2	-0.29351	0.4756	0.9484	
OLIVIN	17	1.24775	0.28775	18.8002	3	-0.40205	0.4725	1.7353	
					4	-0.22432	0.5893	0.4755	
					5	-0.22532	0.4989	1.0652	
					6	-0.18633	0.5334	0.3237	
					7	-0.39145	0.4796	1.287	
					8	-0.11042	0.2494	0.1111	
					9	0.15314	0.5020	0.2161	
					10	-0.15766	0.2989	0.2294	
					11	-0.21562	0.4936	0.1399	
					12	0.10421	0.1865	0.0988	
					QUARTZ	14	0.0037	0.0147	
					PLAGIO	16	-0.47582	0.4564	2.6339
					OTHER	18	-0.42471	0.7203	1.9807

F-LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

LIST OF RESIDUALS

CASE	RESIDUAL
1	0.94564
2	-0.37505
3	1.29905
4	-0.46617
5	0.65985
6	0.26220
7	0.05738
8	-0.12014
9	-0.36516
10	0.67712
11	0.21447
12	-0.12185

FINISH CARD ENCOUNTERED
PROGRAM TERMINATED

STEPWISE DISCRIMINANT E1

PROBLEM CCOE SURVEY

NUMBER OF VARIABLES 25

NUMBER OF GROUPS 4

NUMBER OF CASES IN EACH GROUP 15 25 19 -13
(79F8.3/9F8.3/7F8.3)

DATA INPUT FROM CARDS

MEANS (THE LAST COLUMN CONTAINS THE GRAND MEANS OVER THE GROUPS USED IN THE ANALYSIS)

GROUP	GRANIT	BASALT	PUMICE	TESTGR
1	C.673C0	0.80592	0.05295	0.19954
2	C.31367	0.98764	-0.00816	-0.17231
3	-C.10253	0.63404	-0.22005	-0.39623
4	-0.67893	0.33192	-0.28189	-0.50485
5	-C.96473	-J.00584	-C.36311	-0.62362
6	-1.0807	-0.04704	-C.4358	-0.65038
7	-0.92406	-0.29032	-C.72347	-0.90385
8	-0.66087	-0.64828	-0.00337	-0.9092
9	-C.5867	-0.74496	-1.0300	-1.14400
10	-C.7473	-0.92616	-1.09653	-0.7854
11	-0.562C	-0.72256	-0.65411	-0.8366
12	-0.2580	0.13336	0.01458	-0.66677
13	0.15667	0.28968	0.57305	0.0058
14	C.55907	0.56328	1.11305	-0.25323
15	C.21133	-C.1C1C0	C.59026	0.34712
16	C.02507	-0.18598	0.59737	-0.15862
17	C.65366	0.CC748	0.41116	0.73417
18	-0.1500	-0.24136	0.01342	-0.15862
19	-C.03213	-C.14266	C.322558	0.50223
20	0.03340	-0.32936	0.03258	0.03617
21	C.562C	-0.04022	0.74538	-0.04431
22	C.76813	-C.22664	C.1742	0.73417
23	C.9C3C.	0.C78C0	C.17137	0.91077
24	0.92880	0.26988	0.44389	0.13985
25	1.02040	C.35152	C.42332	0.15469

STANDARD DEVIATIONS

GROUP	GRANIT	BASALT	PUMICE	TESTGR
1	1.85193	1.3637	1.12528	0.84977
2	1.33246	0.88018	1.15921	0.83733
3	1.15146	0.7323	1.07280	0.96447
4	C.811C5	0.80247	C.95889	0.9087
5	C.741C1	C.75395	C.98866	0.82692
6	C.42767	C.69385	C.68262	0.93300
7	C.3C136	C.64344	C.41234	0.53344
8	C.241C3	C.78421	C.69953	0.46385

Reference: SRSL Semi Annual Rep.
May 15 1967
PP 58- 63

• And Appendix A1-A8

("CLOUDS")

0.31910C	0.93873	3.77341	0.43624
0.56282	0.86294	1.06324	0.43143
0.51858	0.96696	1.12502	0.46065
0.56500	0.99367	0.92489	0.51541
0.52714	1.06718	0.627745	0.46411
0.26174	0.54593	0.65386	0.44447
0.46291	1.42113	0.37370	0.51204
0.78184	1.06312	0.58287	0.59486
0.97643	1.31398	0.77140	0.78558
0.97842	0.92769	0.80000	1.04834
0.97102	1.09011	0.81935	0.73957
	1.12643	0.86992	0.31734
0.66137	1.06161	0.61292	0.35749
0.52582	0.79223	0.77879	0.40719
0.46124	0.65395	0.78181	0.56461
0.35097	0.61297	0.67923	0.57680
0.41414	0.54469	0.68033	0.56858

WITHIN GROUPS CORRELATION MATRIX

	E		J					
	1	2	3	4				
18	-0.25674	2.05759	-0.13700	-0.19515				
19	-0.25147	-0.1C3C8	-0.058C7	-0.18108				
20	-0.31249	-0.30676	-0.24590	-0.07112				
21	-0.041071	-0.04100	-0.18889	-0.30324				
22	C.04135	-0.08591	-0.16905	-0.15036				
23	-0.01904	-0.09152	-C.10880	-0.19246				
24	-0.38853	0.02735	0.10911	-0.24495				
25	-0.15643	-0.08818	C.11597	-0.13023				
	VARIABLE	19	20	21	22	23	24	25
	VARIABLE	19	20	21	22	23	24	25

E 4

STEP NUMBER	C	VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM	2	56		
1	1.5983	5 5.3936	9	1.6629	13	1.0927
2	5.2676	6 12.1614	10	0.7063	14	9.3592
3	4.9169	7 8.2462	11	0.1946	15	11.1185
4	6.9304	8 C.9841	12	0.9350	16	4.3203
					20	2.0622
					24	6.2820
					25	7.2026

VARIABLE	GRANIT	BASALT	PUMICE	NUMBER OF CASES CLASSIFIED INTO GROUP -
CONSTANT	-0.	-0.	-0.	CORRECT BASALTIC PUMICE
				-0.

GROUP	GRANIT	DASAL	PUMICE
GRANIT	0	0	15
DASAL	0	0	25
PUMICS	0	0	19
TESTGR	0	0	13

VARIABLES INCLUDED ARE P10 REMOVE - DEGREES OF FREEDOM		2		55	
VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM					
1	1.5632	5	0.0691	10	1.1506
2	3.7428	7	2.7465	11	0.0525
3	2.9935	8	1.0575	12	1.1357
4	2.4196	9	2.3138	13	1.6589
U-STATISTIC		0.69719		DEGREES OF FREEDOM	
APPROPRIATE F		12.16143		1	
APPROPRIATE F		12.16143		2	
		56.00		56	

E 5

	FUNCTION	GRANIT	BASALT	PUMICE							
VARIABLE	GRANIT	BASALT	PUMICE								
6	-2.65803	-0.11767	-1.07902								
CONSTANT	-1.41948	-0.52275	-0.23392								
NUMBER OF CASES CLASSIFIED INTO GROUP -											
GRANIT BASALT PUMICE											
GROUP	GRANIT	11	C	4							
	BASALT	4	17	4							
	PUMICE	5	8	6							
	TESTGR	7	3	3							

STEP NUMBER	2										
VARIABLE ENTERED	15										
VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDM		2	55								
6	11.0636	15	10.0622								
VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDM		2	54								
1	0.3422	5	0.05C6	10	1.9237	14	4.8846	19	1.0158	23	1.7703
2	C.9969	7	1.33C9	11	0.3930	16	0.8921	20	0.7113	24	1.8265
3	1.4914	8	0.50C1	12	1.3462	17	1.1690	21	1.1701	25	1.8141
4	1.589C	9	1.0834	13	1.6451	18	1.3507	22	3.8295		
U-STATISTIC	C.51042		DEGREES OF FREEDM	2	2	56					
APPROXIMATE F	10.59172		DEGREES OF FREEDM	4	110.00						
F MATRIX - DEGREES OF FREEDM	2	55									
GROUP	GRANIT	BASALT									
GROUP	GRANIT	BASALT									
BASALT	1.2.56212										
PUMICE	6.88199										
FUNCTION	GRANIT	BASALT	PUMICE								
VARIABLE	GRANIT	BASALT	PUMICE								
6	-2.63228	-0.12886	-1.00143								
15	C.73781	-0.338CC	2.22318								
CONSTANT	-1.5C213	-0.02C10	-C.98439								
NUMBER OF CASES CLASSIFIED INTO GROUP -											
GRANIT BASALT PUMICE											
GROUP	GRANIT	11	1	3							
	BASALT	5	19	1							
	PUMICE	3	4	12							
	TESTGR	7	6	1							

E6

STEP NUMBER 3

VARIABLE ENTERED 14

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 2 54

6 1C.4788 14 4.8866 15 5.5839

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 2 53

1 1.0262	5 0.1198	10 1.8393	16 1.8102	20 0.5824	24 1.9438
2 1.1864	7 2.4718	11 0.4192	17 1.4062	21 0.0874	25 1.2342
3 1.1986	8 0.4207	12 0.7785	18 1.7027	22 5.9498	
4 1.5568	9 1.4986	13 0.7399	19 1.0195	23 1.3902	

U-STATISTIC 0.43220 APPROXIMATE F 9.37974 DEGREES OF FREEDOM 3 2 56

F MATRIX - DEGREES OF FREEDOM 3 54

GROUP GRANIT BASALT

BASALT 0.08026

PUMICE 7.38292

FUNCTION GRANIT BASALT PUMICE

VARIABLE 6 -2.8C228 -0.3034 -1.31262

14 2.73452 2.80559 5.00559

15 0.32885 -0.75774 1.47457

CONSTANT -2.27652 -0.63585 -3.57923

NUMBER OF CASES CLASSIFIED INTO GROUP -

GRANIT BASALT PUMICE

GROUP GRANIT 12 1 2

BASALT 5 18 2

PUMICE 2 4 13

TESTGR 7 6 0

STEP NUMBER 4

VARIABLE ENTERED 22

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 2 53

6 4.9865 14 7.0625 15 5.8756 22 5.9498

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 2 52

1 4.4C07 4 0.5756 8 1.0244 11 0.9193 16 1.9099 19 1.9264	23 1.0880
2 1.1699 5 C.3668 9 1.4849 12 0.5269 17 1.4028 20 2.3566	24 0.4998
3 C.1305 7 2.4270 10 0.8924 13 0.5881 18 2.6651 21 0.2392	25 0.7546

E7

U-STATISTIC APPROXIMATE F		9.05262	DEGREES OF FREEDOM	4	2	56
F MATRIX - DEGREES OF FREEDOM		4		8	196.00	
GROUP	GRANIT	BASALT				
GROUP	GRANIT	BASALT				
FUNCTION	GRANIT	BASALT				
VARIABLE	-2.22873	-0.234C9	-0.74122			
6	4.1C155	2.97165	6.36727			
14	0.62459	-0.72C82	1.77911			
15	2.15666	C.26C4C	2.14816			
CONSTANT	-3.2C692	-0.84941	-4.50236			

NUMBER OF CASES CLASSIFIED INTO GROUP -						
GRANIT BASALT PUMICE						
GROUP	GRANIT	11	2	2		
	BASALT	5	18	2		
	PUMICE	2	3	14		
	TESTGR	8	5	0		

STEP NUMBER	5					
VARIABLE ENTERED	1					
VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM						
		2	52			
1	4.4C7	6	3.2270	14	6.7874	15
					7.5389	22
						9.8383
VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM						
		2	51			
2	C.5896	5	0.32BC	9	3.2C9	12
3	C.617	7	1.7599	10	2.9019	13
4	1.0586	8	1.92CC	11	1.6242	16
U-STATISTIC APPROXIMATE F	C.30186	CEGRES OF FREEDOM	5	2	56	
	8.52903	CEGRES OF FREEDOM	1C	104.00		
F MATRIX - DEGREES OF FREEDOM						
		5	52			
GROUP	GRANIT	BASALT				
GROUP	GRANIT	BASALT				
FUNCTION	GRANIT	BASALT				
VARIABLE	1	1.65524	0.342C3	0.88438		

E8

GROUP WITH LARGEST PROB.		SQUARE OF DISTANCE FROM AND POSTERIOR PROBABILITY FOR GROUP -						
GROUP	CASE	GRANIT	GRANIT	BASALT	PUMICE	GRANIT	BASALT	PUMICE
6	-1.96887	-0.17940	-0.17940	7.990	0.234	11.600	0.038	
14	3.96310	2.94252	2.94252	6.29197		6.815	0.077	
15	2.56759	-0.30573	-0.30573	2.84170		4.026	0.198	
22	4.12064	0.67583	0.67583	3.22198		3.099	0.472	
CONSTANT	-4.55113	-0.91072	-0.91072	-4.91195		3.241	0.324	
GROUP	CASE	BASALT	BASALT	BASALT	PUMICE	BASALT	BASALT	PUMICE
1	BASALT	10.031	0.061	4.737	0.867	9.735	0.071	
2	BASALT	7.368	0.197	4.580	0.793	13.225	0.011	
3	BASALT	26.198	0.001	14.813	0.957	21.076	0.042	
4	BASALT	8.180	0.225	5.059	0.703	10.431	0.073	
5	BASALT	15.373	0.004	4.652	0.806	7.535	0.190	
6	BASALT	8.199	0.035	2.097	0.147	4.560	0.218	
7	BASALT	11.852	0.007	1.822	0.988	12.151	0.006	
8	BASALT	13.499	0.037	3.441	0.991	15.488	0.002	
9	BASALT	6.807	0.135	3.413	0.137	6.921	0.128	
10	BASALT	3.614	0.287	2.229	0.574	5.074	0.138	
11	BASALT	20.639	0.002	17.277	0.931	22.522	0.068	
12	BASALT	12.740	0.011	3.054	0.377	12.711	0.012	
13	BASALT	31.968	0.00C	11.703	0.998	23.903	0.002	
14	BASALT	15.537	0.003	3.710	0.992	14.065	0.006	
15	BASALT	7.925	0.085	3.289	0.860	8.773	0.055	
16	PUMICE	6.479	0.247	7.638	0.138	4.652	0.615	
17	PUMICE	10.405	0.107	8.339	0.223	6.737	0.670	
18	BASALT	15.221	0.002	2.431	0.984	10.842	0.015	
19	BASALT	7.691	0.133	4.196	0.764	8.215	0.102	
20	BASALT	4.823	0.158	1.946	0.666	4.606	0.176	
21	GRANIT	4.251	0.454	4.272	0.449	7.350	0.096	
22	BASALT	7.969	0.034	1.951	0.780	4.862	0.192	
23	GRANIT	7.713	0.478	8.127	0.388	10.252	0.134	
24	BASALT	9.763	0.212	7.186	0.770	14.659	0.018	
25	BASALT	3.659	0.205	1.228	0.522	2.558	0.269	

E9

GROUP	PUMICE	GRANIT	BASALT	PUMICE
CASE				
1	PUMICE	11.498 C.021,	8.946 0.075,	3.958 0.904
2	PUMICE	5.142 0.154,	9.2C7 0.020,	1.777 0.826
3	PUMICE	5.118 C.095,	8.524 0.017,	0.644 0.888
4	PUMICE	5.526 0.081,	7.532 0.029,	0.712 0.890
5	BASALT	7.984 C.061,	2.588 0.614,	3.746 0.344
6	PUMICE	6.796 C.258,	7.872 0.174,	5.653 0.528
7	PUMICE	14.C58 0.068,	13.792 0.009,	4.427 0.983
8	PUMICE	11.332 0.023,	10.442 0.036,	3.887 0.942
9	PUMICE	4.712 0.365,	11.705 0.011,	3.636 0.624
10	BASALT	1C.659 C.200,	9.01C 0.455,	9.567 0.345
11	BASALT	9.171 C.024,	2.102 0.824,	5.49C 0.152
12	BASALT	1C.502 C.009,	1.188 0.979,	10.122 0.011
13	PUMICE	7.777 0.440,	25.013 0.001,	7.612 0.519
14	PUMICE	6.886 0.085,	7.898 0.036,	1.52C 0.879
15	GRANIT	1.999 0.923,	9.114 0.026,	7.784 0.051
16	GRANIT	2.409 0.919,	9.663 0.024,	7.974 0.057
17	PUMICE	8.164 0.055,	11.907 0.008,	2.478 0.937
18	PUMICE	11.858 C.030,	16.934 0.002,	4.901 0.968
19	PUMICE	15.039 C.018,	21.7C5 0.001,	7.370 0.982

GROUP	TESTGR	GRANIT	BASALT	PUMICE	USGS
CASE					
1	73	GRANIT	1.496 C.043,	9.413 0.018,	7.867 0.039
2	74	GRANIT	1.279 0.233,	9.138 0.018,	7.201 0.048
3	85	GRANIT	2.278 0.293,	6.706 0.017,	6.175 0.114
ACID	4 75	GRANIT	1.330 C.084,	7.829 0.034,	PUMICE
(none)	5 79	GRANIT	1.464 C.711,	9.012 0.016,	PUMICE
6 80	GRANIT	1.639 0.422,	8.301 0.022,	BISHOP TUFF	
7 78	GRANIT	1.639 0.382,	8.271 0.033,	BISHOP TUFF	
8 77	GRANIT	7.112 0.456,	8.458 0.334,	Q MONTZ	
9 72	BASALT	15.308 0.124,	11.395 0.012,	PANDEMONIUM	
10 84	GRANIT	6.872 C.068,	10.869 0.118,	AA	
11 86	BASALT	7.933 0.182,	4.999 0.750,	AA Rouch	
(PSCM)	12 91	BASALT	8.705 C.550,	8.371 0.522,	AA
13 90	BASALT	34.935 C.001,	21.683 0.999,	15.084 0.019	
					AA

NUMBER OF CASES CLASSIFIED INTO GROUP -
GRANIT BASALT PUMICE

GROUP	GRANIT	BASALT	PUMICE	TESTGR
	14	21	1	
	2	2	2	
	4	4	13	
	9	4	4	C

SUMMARY TABLE

E10

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC
1	6		12.1614	1	0.6972
2	15		10.0622	2	0.5104
3	14		4.8866	3	0.4322
4	22		5.9498	4	0.3530
5	1		4.4007	5	0.3019
EIGENVALUES					
	1.22153	0.49121	0.00000	0.00000	-0.00000
CUMULATIVE PROPORTION OF TOTAL DISPERSION					
	0.71320	1.00000	1.00000	1.00000	1.00000
CANONICAL CORRELATIONS					
	0.74152	0.57394	0.00014	0.00004	0.00001
COEFFICIENTS FOR CANONICAL VARIABLE -					
ORIGINAL VARIABLE	1	2	3	4	5
1	-0.41917	0.35495	-0.35396	-0.69235	-0.21862
6	0.50869	-0.69083	-1.38385	-0.10397	-0.22500
14	-0.95349	-1.42199	0.04781	-0.53769	1.59336
15	-1.38253	-0.32404	-0.37955	-0.28331	-1.60995
22	-1.37437	0.32097	-1.33045	-0.11197	0.36402
GROUP CANONICAL VARIABLES EVALUATED AT GROUP MEANS					
1	-1.05395	0.95965	0.00000	0.00000	0.00000
2	1.25129	0.06678	0.00000	-0.00000	-0.00000
3	-0.81437	-0.85549	0.00000	0.00000	0.00000
4	-0.01462	1.64016	-0.69896	0.68850	-0.68838
CHECK ON FINAL U-STATISTIC					
			0.30186		

POINTS PLTTED ON THE FOLLOWING GRAPH

X = FIRST CANONICAL VARIABLE

Y = SECINE CANONICAL VARIABLE

CASE NUMBER FOLLOWED BY * INDICATES THE POINT IS OFF THE GRAPH

GROUP GRANIT MEAN COORDINATES -1.054 0.560

CASE	X	Y
1	0.115	1.825
2	-1.406	1.360
3	-1.329	0.765
4	-1.206	0.044
5	-0.050	0.209
6	-0.202	1.242
7	-1.862	1.557
8	-0.566	1.291
9	-1.500	0.828
10	-0.701	1.112

GROUP BASALT MEAN COORDINATES 1.251 0.067

CASE	X	Y	CASE	X	Y
1	1.165	0.251	11	1.950	-1.526
2	1.208	1.972	12	1.957	-0.438
3	2.223	-1.496	13	3.690	-1.563
4	0.734	0.903	14	2.506	0.106
5	1.514	-1.785	15	1.124	0.565
6	0.952	-0.705	16	-0.503	-0.392
7	2.295	0.568	17	-0.111	-0.850
8	2.483	1.087	18	2.358	-0.714
9	0.757	0.313	19	0.827	0.436
10	0.430	0.645	20	0.662	0.201

GROUP PUMICE MEAN COORDINATES -0.814 -0.845

CASE	X	Y
1	-0.302	-1.945
2	-1.342	-0.929
3	-1.317	-1.233
4	-1.037	-1.285
5	0.723	-0.897
6	-0.477	-0.190
7	-1.660	-2.627
8	-0.610	-1.970
9	-1.052	-0.349
10	0.222	-0.792

GROUP TESTGR MEAN COORDINATES -0.015 1.643

CASE	X	Y
1	-1.121	1.797
2	-1.159	1.668
3	-0.003	1.181
4	-0.982	1.370
5	-1.541	0.548

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E12

6	-1.277	1.028
7	-1.015	1.345
8	C.561	2.460
9	1.610	2.381
1C	-0.C18	2.459

OVERLAP IS INDICATED BY \$, GROUP MEANS BY *.

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